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PART III

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Observations on some Ceylonese Mantidae with descriptions of new species

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(With Five Plates and One Text Figure)

The Colombo Museum now possesses a very fine collection of the Island's Mantid fauna, and in studying this material some new species have come to light and fresh information about others has been obtained which makes it desirable to record these facts in print.

Very little is on record concerning the lives of Mantidæ (not to mention other insects), and it is hoped, therefore, that the accounts of habits and life-histories given may not come amiss. In this connection it may be useful to place on record the technique which I have found most successful in rearing the young larval stages of Mantidæ, as it is often very difficult to supply them with insects small and numerous enough for their needs. Ripe plantains are exposed to the attentions of *Drosophila* sp., and when they are full of maggots they are placed in the mantis cages, fresh plantain being introduced every few days. In this way a constant supply of the small flies is forthcoming and the young mantises feed greedily upon them. By this means the necessity for constant disturbance of the larvæ is obviated, and they thrive apace and are less inclined to indulge in cannibalism in the presence of abundant fly food. After the third or fourth ecdysis many species become too large for *Drosophila* and require larger flies and small grasshoppers, etc., which are swept with butterfly nets from grassland and introduced into the cages. On this *régime* large numbers of mantises of many species have been successfully reared from the egg in my laboratory.

My grateful thanks are due to Dr. B. P. Uvarov, of the Imperial Institute of Entomology, for much time spent in unravelling my difficulties and assisting me in other ways.

Sub-family Eremiaphilinae

Dysaules uvana sp. nov.

(Plate I and Plate II, fig. 1)

It is with considerable hesitation that I have decided to describe the species now under consideration as new, as it agrees very closely with the description of *D. longicollis* Stål (1877, pp. 14 and 18) (the genotype) from Bengal and with that of *D. himalayanus* Wood-Mason (1889, p. 42) from the North-Western Himalayas. The descriptions of both the above are, however, so meagre and unsatisfactory that, without examining the types or, at least, material from the type localities it is impossible to decide as to the real relationship of the present species with either.

Through the courtesy of the Authorities of the Indian Museum, I have been able to examine Wood-Mason's specimens $\frac{519}{1}$ *a* and $\frac{519}{1}$ *b*, determined by him as females of *D. longicollis* Stål, but owing to their fragile condition the types of *D himalayanus* W.-M. could not be sent. The type of *D. longicollis* Stål is not mentioned by Sjöstedt (1930) and its location is unknown to me. The proposed new species may be described as follows :

Size larger than either *D. longicollis* Stål or *D. himalayanus* W.-M., with a proportionately longer pronotum.

♂. Head much wider than the pronotum, in full-face view forming almost an equilateral triangle, with the sides bowed outwards and the vertex deeply concave, its margin slightly bisinuate on each side. The facial scutellum transverse, its height rather more than half its width ; somewhat angularly arched above, bearing two small gibbosities on its lower margin but with no longitudinal carinae. Eyes longly oval, not pointed above.[1] Ocelli large and prominent. Antennae about half as long again as the head and pronotum together.

Pronotum broadly rounded in front and behind with only a trace of a longitudinal carina ; prozona occupying about a quarter of its length, narrowest in the middle. Supra-coxal expansion fairly pronounced, the metazona narrowest just behind it, then gradually widening until, at its posterior end, it is as wide as the supra-coxal expansion. The prosternum, posterior to the coxal insertion is broadly channelled on each side, for the length of the fore-coxæ, to provide lodgment for the latter while at rest ; in profile, the prothorax is slightly deflexed posterior to the supra-coxal expansion, and is very shallow for the length of the

1. In very few of the specimens examined have I been able to discover on the apex of the eyes "the minute and smooth granule representing the ocular spine of the allied genera" mentioned by Wood-Mason as characteristic of this genus.

prosternal channels, then rather suddenly deepened ; this is well shown in Plate II, fig. 1, which is a photograph of the living insect (female). The metazona curves slightly upwards towards its posterior extremity.

The fore-coxæ bear a few small teeth on the anterior carina. The fore-femur has its dorsal margin slightly concave in the distal half, the carina in the same region being slightly bowed outwards. The unguicular sulcus is a little proximal to the middle of the femur. The discoidal spines are four in number, arranged in an almost straight line. Just distal to the fourth there is a small circular pit for the reception of the last external tibial spine when the limb is flexed. There are five external spines, of which the first is about two-thirds the length of the second, the remaining three, which are all about the same size, being not much more than half its length. The internal spine formula is as follows: ıIıIıIıIıIıı(ı)I; the small distal spine shown in brackets may be present or absent. Each of the genicular lobes bears a small spine. The tibiæ bear 12 to 13 external and 14 internal spines (not counting the terminal hook).

The mid and hind femora are nearly cylindrical, and bear a small sharp spine on the anterior margin of their extremity just above the genicular lobe. The mid and hind tibiæ are straight, nearly cylindrical, and bear each a pair of small distal spurs. The metatarsi of these legs are about as long as the next two joints together.

The tegmina are almost colourless hyaline, with the veins stramineous and slightly infuscated in the discoidal area. The wings are colourless hyaline with their veins rather deeper coloured than those of the tegmina. On the disc of their anal area there is a large fuscous, oval blotch strongly illuminated with blue and violet iridescence ; distal to this spot there are six or seven concentric macular bands of the same colour which do not reach the edge of the wing. Between the first three of these bands, the inter-venular spaces are occupied by opaque yellow spots.

The shape, venation, pattern and proportions of the alaıy organs may be seen in Plate I, fig. 3.

The abdomen is long and slender and surpasses the tips of the closed wings by one or two segments. The cerci, of about 15 joints, are laterally compressed, especially distally, and taper gradually to their free extremity.

Colouration. In colour the male is pale yellowish brown with stramineous legs. The tips of the external, discoidal, and small internal spines on the fore-femora are black, likewise the whole of the large internal spines with a spot at the base of each. There is a black spot at the proximo-internal extremity of the fore-femur, one at the base

of the first discoidal spine and a small one on the dorsal carina near the distal end. The tips of the external, and the greater part of each of the internal tibial spines and a longitudinal line on the ventro-internal surface of the fore-tarsi are also black, likewise the basal halves of all the palpal joints. The flexor surface of the anterior tibiæ is yellowish brown.

The pre-coxal portion of the prosternum is purplish brown; the inner surface of the fore-coxæ is chrome yellow in ground colour and a band of this colour, set in the middle of a reddish brown patch, crosses the prosternum between the coxæ. The basal half of the internal surface of the coxæ is purplish brown, and the whole of this coloured region forms a "scare-mark" which is displayed by the insect when it is threatened by an enemy.

♀. The female is considerably larger and heavier than the male and has a disproportionately large head with much smaller ocelli. Her antennæ are shorter than the pronotum and, as usual, finer than those of the male.

Her pronotum is less constricted in the middle of the prozona than his, and its margins are denticulate. The prosternum is of the same structure, also the fore-legs, with their spine formulæ.

The female alary organs are abbreviate, reaching only to about half the length of the abdomen. Unlike those of the male they are semi-opaque.

There are two colour varieties of the female: first. a strongly pigmented form with a general ground colour of dark purplish grey (altering to dark brown in dried specimens) mottled with fuscous. In this form the tegmina are grey (reddish brown in dry specimens), more or less mottled with fuscous, with an ill-defined, discal, fuscous blotch just distal to the stigma and a fuscous apical patch. The wings are castaneous in the costal and discoidal areas, with a small fuscous apical patch, and semi-hyaline, smoky spots between the discoidal cross-veins. The anal area is rich ochreous yellow, with a large, discal, oval blotch of fuscous, illuminated, as in the male, with brilliant purple and blue iridescence. This blotch is succeeded by concentric, broken bands of the same colour which tend to amalgamate towards the edge of the wing, forming a fuscous margin.

The "scare-marks" on the prosternum and fore-coxæ of this form are as in the male, but the blotch on the basal half of the coxa is pale opaque ashy grey indefinitely outlined with black.

The other variety is, in life, a pale washed-out-looking, greyish or yellowish pink, with all the markings paler and the tegminal discal blotch, and sometimes the apical blotch also, almost obsolete. The

wings, however, are but little paler than in the dark form. Between these two extremes, specimens of every grade of pigmentation exist, and some of them have a good deal of green about them, particularly on the limbs. The range of variation seems to be much smaller in the males.

Measurements : In the table on p. 6 are given the measurements of *D. longicollis* ♂ as given by Stål (1877, p. 18), (said by him, but obviously by mistake, to be a ♀), *D. longicollis* ♀♀ (Wood-Mason's specimens $\frac{519}{1}a$ and $\frac{519}{1}b$) re-measured by myself ; *D. himalayanus* ♂ and ♀ as given by Wood-Mason (1889, p. 42), and *D. uvana*, 3 ♂♂ and 3 ♀♀.

Material examined. One male (*Type*) and three females collected as half-grown larvæ at Wellawaya (ca. 800 feet) on 28-iv-31, and reared to maturity in the laboratory ; also 13 males and 21 females reared from eggs laid by the three females and fertilized by the male above mentioned. In addition, several complete sets of each instar have been preserved in spirit.

Several specimens of both sexes, including the *type* will be deposited in the British Museum of Natural History on publication of this paper ; specimens will be presented to the Indian Museum, Calcutta ; the remaining paratypes are in the Colombo Museum.

Habits, etc. The original specimens were captured in long grass in park-like country. Similar larvæ had been taken at Bandarawela (ca. 4,000 feet) earlier in the same month but had escaped. Both localities are in the Province of Uva—whence the specific name.

In captivity they spent much time crouched along dry twigs or grass stems with the face looking downwards and the fore-legs flexed and laid close against the prosternum (Plate II, fig. 1). In this position they formed compact, linear objects, very hard to distinguish from the dry twigs, etc., amongst which they lived. Some individuals, which were kept in a roomy outdoor cage with a living shrub were extremely sluggish and occupied the same position for days. In small indoor cages, where they were overcrowded, they spent a lot of time running and leaping about in attempts to get away from their neighbours. They were strongly positively phototactic, generally being massed on the side of the cage nearest to the light.

When approached by an enemy, especially one of their own kind, they would rear up the fore-part of the body and curve the abdomen upwards, at the same time extending the raptorial legs laterally and so displaying the " scare-marks " on the prosternum and fore-coxæ. The tegmina and wings were also raised and displayed, and this threatening action generally had the effect of " warning off " one of their number

Table giving measurements of D. longicollis, D. himalayanus and D. uvana

	Males					Females					
	D. longicollis Stål.	*D. himalayanus* W.-M.	*D. uvana* sp. nov.			*D. longicollis* Stål. 519/1 *a* W.-M.	*D. longicollis* Stål. 519/1 *b* W.-M.	*D. himalayanus* W.-M.	*D. uvana* sp. nov		
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Length of body	53·0	51·0	55·0	58·0	56·0	—	—	56·0	60·0	65·0	65·0
Length of pronotum	16·0	15·25	18·0	18·5	18·0	18·5	18·0	18·0	20·2	21·5	21·0
Length of metazona	12·0	—	14·0	14·0	13·8	14·0	13·0	—	15·0	16·2	16·0
Length of tegmen	31·0	31·5	31·0	31·0	31·0	15·5	16·0	19·0	19·0	22·0	22·0
Length of wing	29·0	31·0	29·0	29·0	29·0	12·0	12·5	15·0	16·5	18·0	18·5
Length of fore-coxa	8·0	—	8·0	8·5	8·0	9·3	9·5	—	10·0	10·0	10·0
Length of fore-femur	11·0	—	11·0	11·0	11·0	11·5	11·4	—	12·0	13·5	13·1
Length of hind femur	9·0	—	10·0	10·0	10·5	10·0	9·0	—	10·0	11·0	11·0
Length of hind tibia	—	—	10·5	10·7	10·5	10·0	9·5	—	11·0	12·0	12·2
Width of head	5·0	—	4·65	4·5	4·4	5·5	5·3	—	5·2	6·0	5·5
Width of frontal scutellum	—	—	1·7	1·7	1·7	2·0	2·0	—	2·0	2·1	2·1
Width of prozona in middle	—	—	1·9	2·0	2·0	2·75	2·75	—	2·6	3·0	3·0
Width of supra-coxal expansion	3·0	—	3·0	2·8	2·9	3·4	3·2	—	3·4	3·8	3·75
Width of metazona, minimum	—	—	1·75	1·75	1·75	2·4	2·2	—	2·1	2·3	2·3
Width of metazona, maximum	—	—	2·75	2·75	2·75	3·2	3·0	—	3·0	3·2	3·5
Width of tegmen	7·5	—	8·0	8·0	7·0	—	6·0	6·0	6·0	7·0	7·2
Width of wing	15·0	—	16·0	15·0	15·5	—	—	—	13·0	14·0	13·5
Length of cercus	—	—	6·0	5·5	6·0	5·8	—	—	6·0	7·0	6·5
Length of face	—	—	3·8	3·8	3·75	5·4	5·1	—	5·0	5·5	5·5

whose approach was resented. Even quite young larvæ adopted this attitude but evidently preferred the maxim that " he who fights and runs away, will live to fight another day."

The type male coupled with all three of the first batch of females, each of which produced a number of egg-masses up to six, and it is almost certain that more would have been laid had not the individuals been killed for specimenizing. These oothecæ, which were laid at night, hatched in from 22 to 25 days, each producing a large brood of larvæ which were fed in their early stages on *Drosophila* flies (see remarks in the introduction) and later on house-flies and small grasshoppers, etc. The precise number of moults was not accurately observed, as owing to shortage of cages, large numbers of larvæ had to be kept together, and therefore the different stages overlapped to some extent. The entire larval period occupied three months. I am indebted to my Assistant Mr. T. R. Sandrasagara for keeping these records, and to my Collector, K. L. A. Perera for keeping the young mantises well supplied with food—no easy task.

Ootheca (Plate I, fig. 4). This is a beautiful object, of a golden yellow colour, broadly oval and rather depressed in shape, and typically bearing at the posterior end a long, free filament. The central egg mass is enclosed on each side by a deep layer of solidified, semi-transparent froth arranged in transverse layers. The hatching orifices are in two series of alternating vestibules which are concealed by a longitudinal median yellow band of spongy substance. Within the central mass, the eggs are arranged in cells with the regularity of those of a honeycomb, and a typical ootheca possesses 10 transverse rows and 18 to 20 longitudinal. Horizontal sections show that the five egg-cells in one transverse half-row open into a common vestibule, those of the corresponding half-row on the other side opening into the next vestibule. It is difficult to understand how the mantis is able to produce so complicated a structure. The ootheca measures roughly 20 to 24 mm. long, 13 broad and 7 or 8 deep, and the projecting, fibre-like filament may measure as much as 30 mm.

Dysaules sp.

Parepiscopus hampsoni, Wood-Mason, Cat. Mantod., 1889, p. 40, fig. 30.

Through the courtesy of the Authorities of the Indian Museum, I have been enabled to examine the unique type of *Parepiscopus hampsoni* Wood-Mason, and it proves to be a larva of *Dysaules* sp.—almost certainly the same as the specimens, from Bangalore, determined by Wood-Mason as *D. longicollis* Stål (see remarks under previous species,

p. 2). The special feature, apparently, which induced him to adopt the very questionable course of erecting the genus *Parepiscopus* on a single very young larva was the different shape of the head from that of *Dysaules*, but, having reared specimens of the latter from the egg I am able to state that the eyes in the nymph are very much more pointed dorsally than they are in the adult, and in fact, agree exactly with the figure given by Wood-Mason at the same stage of development.

Parepiscopus, therefore, falls as a pure synonym of *Dysaules*. Whether *P. hampsoni* W.-M. is a synonym of *D. longicollis* Stål, or not, can only be determined by further collecting on the Peninsula of India.

Oxyophthalmus gracilis Sauss.

(Plate III)

Oxyophthalmus gracilis Saussure, Ann. Soc. Ent. de France, 1862, p. 470, Pl. 11, figs. 1, 1*a*.
Oxyophthalma gracilis Saussure, Mel. Orthopt., 1871, p. 395.
Oxyophthalmus engaeus Wood-Mason, Cat. Mantod., 1889, p. 37, fig. 28.

A female specimen of an *Oxyophthalmus* was taken at Wellawaya 29- to 31-xii-27 on the ground in scrub jungle, and as it appears to be intermediate between the genotype and Wood-Mason's species—the differences between which in any case are very slight—the latter must be regarded as a synonym. In measurements and colour our specimen agrees better with *O. engaeus* than with *O. gracilis*, and its cephalic appearance is much more like Wood-Mason's figure than Saussure's (loc. cit.); the latter point, however, is not of great importance, for Saussure's figures are too small and obviously badly drawn to give a really good idea of the appearance of the insect; our specimen, however, like Saussure's has two slight carinæ on the facial scutellum; (in this connection it is noteworthy that Wood-Mason's specimens were all preserved in spirit, whereas ours', and presumably Saussures', are dry; this fact may well account for the apparent absence of carinæ in Wood-Mason's specimens, as these would naturally become accentuated through shrinkage in drying). It is very probable that this species, like so many other Mantidæ, has several colour varieties and that Saussure's specimen, "probablement vert pendant la vie," was of a light coloured race.

The fore-tibial armature of our specimen is, external spines 7-8, internal 9-8. Its measurements are as follows :—

	♀ mm.		♀ mm.
Length	29·0	*Length of tegmen* ..	13·0
Length of head in middle line	3·15	*Length of wing*	11·2
Width of head	2·9	*Length of fore-coxa* ..	3·3
Width of facial scutellum ..	1·1	*Length of fore-femur* ..	4·1

	♀ mm.		♀ mm.
Length of pronotum ..	7·0	*Length of mid-femur* ..	3·5
Width of pronotum at supra-coxal expansion ..	1·8	*Length of hind femur* ..	6·0

Giglio-Tos (1927, p. 114) unites *Oxyophthalmus* and *Didymocorypha* in the group Oxyophthalmæ, but *Oxyophthalmus* would, in my opinion, be more happily placed with the group Dysaules, with which it shows closer affinity than with *Didymocorypha*.

Didymocorypha lanceolata (F.)

(Plate IV)

A female of this species was captured in mana-grass park country at Randeniya Estate, Wellawaya on 7-i-28, another at Bandarawela on 16-iv-31 and a third at Wellawaya in April, 1931. The latter two, being kept alive for some time each produced oothecæ, proving that they were adult, and as their measurements agree closely with those given by Wood-Mason (1877, p. 222,—*D. ensifera*), I have no doubt that he was actually dealing with an adult female, and not a nymph as he supposed. This conclusion is supported by the fact that the female is larviform, its alary organs being rudimentary in the extreme and suggestive of a very early stage of wing development in a macropterous mantis. (See Plate IV, fig. 1).

The Randeniya specimen is considerably larger than the other two, but as I can discover no structural differences I conclude that it is the same species.

As in *Dysaules* and *Oxyophthalmus*, the prosternum is deeply channelled on both sides of the middle line, posterior to the coxal insertion, for the reception of the flexed coxæ. This structure does not appear to have received the attention from systematists that it deserves, very few references to it being mentioned in keys, diagnoses of sub-families, groups or genera. Being correlated with a deep-seated habit —that of holding the raptorial legs, while at rest, closely flexed against the prosternum—it would seem to be a character of much greater importance than some of those extensively used such as relative concavity of the vertex, precise length of alary organs, etc. In genera such as *Deiphobe*, *Tenodera*, etc., the normal resting attitude is with the raptorial legs fully extended in front and they are only flexed when the insect wishes to strike ; accordingly we find that in these genera the prosternum is not sulcated for the reception of the flexed coxæ.

The ootheca measures 10 to 14 mm. in length, 1·5 to 2 mm. in breadth and 1·8 to 2 mm. in depth. In shape it is long, lanceolate,

tapering at both ends to the base and with the rather large eggs in two rows, set very obliquely and somewhat exposed at the sides.

The male of this species is apparently far commoner than the female, as the Colombo Museum possesses 18 specimens of this sex from the following localities :—Bandarawela (4,000 feet), Hakgala (ca. 6,000 feet), Haldummulla (ca. 4,000 feet), Buttuwa Modera, S.P. (sea-level), Wellawaya (ca. 700 feet). It inhabits open grassy country but does not seem particular as to the type of grass, as I have taken specimens in tall illuk and mana-grass as well as amongst short patana grass.

Sub-family **Iridopteryginae**

Hapalopezella maculata (Kirby)

Hapalopeza maculata Kirby, Ann. Nat. Hist., 1904, Series 7, Vol. 13, p. 84.
Hapalopezella maculata, Giglio-Tos, Bull. Soc. Ent. Ital. 1915, Vol. 46, p. 43.
Diacanthomantis bispinosa Giglio-Tos, *ibid.*

While working at the collection of Mantidæ in the British Museum (Natural History) in 1930 I examined the type specimen of *Diacanthomantis bispinosa* Giglio-Tos, and at once recognized it as a larval form of either *Iridopteryx* or *Hapalopezella*, but was unable to be quite certain to which of these genera it belongs. On my return to Ceylon, an early opportunity was sought of obtaining specimens of this larva for rearing to maturity, and a day's collecting at Labugama on 19-ii-31 provided three individuals of different instars. The youngest of these disappeared—doubtless through its companions' cannibalistic propensities—but the others attained maturity and prove to be *Hapalopezella maculata* (Kirby). The genus *Diacanthomantis*, being monotypic, therefore disappears, and *D. bispinosa* Gig.-Tos. becomes a pure synonym of *Hapalopezella maculata* (Kirby).

Sub-family **Mantinae**

Hierodula versicolor sp. nov.

(Plate V, fig. 1)

Of medium size for the genus. Head much wider than the pronotum, its ventral angle in ♀ almost a right angle, in ♂ one of approximately 100.°

Facial scutellum transverse, its height about two-thirds of its width, sides parallel, not bicarinated, slightly arched below and more strongly above, the dorsal margin in the ♂ being roundedly angulate. Ocelli in ♂ fairly large and arranged in a right-angled triangle, in ♀ small and arranged in a slightly more than right-angled triangle.

Pronotum with the dilatation well marked, broadest above coxal insertions, narrowest about the middle of the metazona ; sides of prozona converging rather steeply anteriorly, very slightly sinuated. Shaft carinate and somewhat tectiform in ♀, rounded in section in ♂. Lateral margins of prozona and anterior three-fifths of metazona in ♀ finely tuberculate, in ♂ very indistinctly crenulate.

Fore-coxæ shorter than metazona, their anterior carina armed irregularly with small oblique spinous tubercles of several sizes, the number of which in the ♀ ranges from about 13 to 20, in the ♂ from 3 or 4 to about 7. The dorsal and posterior carinæ also are minutely tuberculate, especially in the ♀.

Fore-femoral armature typical for the genus ; both inner and outer genicular lobes armed with a minute, blunt tubercle.

Tegmina in ♂ extending well beyond the abdomen, in ♀ only to about its middle. Costal margin smooth (in a strong light, minute setae can be detected under considerable magnification), in ♂ the costal area is opaque, remainder colourless hyaline. In the ♀ the whole tegmen is opaque except the anal membrane and small irregular patches in the discoidal and anal areas. In both sexes the wing membrane is colourless hyaline except in the costal area which is slightly opaque. The tegminal venation shows great variation in the number of branches of the median vein (1 to 3) and ulnar (2 to 3), while the branching of the discoidal may be proximal or distal to the stigma.

The anterior margin of the distal extremity of the mid and hind femora is armed with a small spine. The metatarsus of the hind legs is longer, in both sexes, than the remaining tarsal joints.

Colouration. The following description was drawn up from living or freshly killed individuals, and allowance must be made for discolouration in the examination of preserved examples.

♂. Light green. Antennæ pinkish brown. Facial scutellum purple. Vertex and ocellar region pinkish purple. Eyes greenish yellow. The green of occiput and pronotum is overlaid by a whitish efflorescence. Mouth parts pale brownish, labium orange. Prosternum, except around coxal acetabula, opaque purplish black. Inner surface of fore-coxæ chrome-yellow-green ; a chrome-yellow band crosses the prosternum between their acetabula. Proximal six of the major internal femoral spines black, the other spines all black tipped. The discoidal spines, and proximal internal minor spine, are somewhat streaked with black also. There are no other black marks on the fore-limbs. Ventral and lateral areas of meso- and meta-thoraces, their coxæ and the venter of abdomen pale pinkish brown. Dorsum of abdomen bright green. Mid and hind legs dirty green, the hind femora inclined to pinkish brown.

Extreme costal margin of tegmen opaque white. Costal area bright green above, verditer blue beneath, rest of tegmen colourless hyaline with pale greenish veins. Stigma chrome-yellow. Wings colourless hyaline with veins in costal area pale green.

♀. The female passes through two very distinct colour phases. For the first fortnight, at least,[1] of imaginal life, she shows the following colouration : dull glaucous green, pronotum with a chalky bloom ; prosternum pale, dirty chrome-yellow, also the inner faces of fore-coxæ (the green ground colour showing through). Ventral half of inner face of fore-femora suffused with pinkish. Femoral spines coloured as in the male. Tegmina green above with the discoidal and anal areas much broken up with irregular hyaline spots. Stigma bright chrome-yellow. Ventral side of costal area verditer blue.

Costal area of wings opaque greenish white ; remainder hyaline with pale pink veins.

The fully mature female changes to a pale, opaque yellowish brown with a pinkish tendency. Eyes various shades of pinkish grey. Entire inner face of fore-coxa and band across prosternum dark purplish grey. Shaft of prosternum dull yellow. Ventral half of inner face of fore-femur suffused with pink. Tegmina, above, pale opaque yellowish brown with stigma stramineous ; beneath, in costal area, opaque, greyish rose, remainder rich glossy brownish crimson. Wings with costal area opaque rose above and below, remainder hyaline with deep crimson veins and cross-veins.

Measurements :

	♂ mm.	♀ mm.
Length of body	47·0 to 56·0	46·0 to 51·0
Width of head	6·5 to 6·8	7·0 to 7·6
Width of facial scutellum	2·0	2·3 to 2·5
Height of facial scutellum	1·2 to 1·3	1·75 to 1·8
Length of pronotum	16·5 to 17·0	16·0 to 17·5
Greatest width of pronotum	4·8 to 5·0	5·1 to 6·2
Least width of pronotum	2·9 to 3·0	3·0 to 3·5
Length of metazona	12·2 to 12·7	11·3 to 12·5
Length of tegmen	38·0 to 40·0	17·6 to 20·3
Width of tegmen	9·6 to 10·0	8·0 to 10·0
Width of costal area of tegmen	2·5 to 2·75	3·0 to 3·5
Length of wing	34·0 to 35·0	14·0 to 16·0
Length of fore-coxa	9·5 to 10·5	10·5 to 12·0
Length of fore-femur	11·2 to 12·0	12·0 to 13·5
Length of hind femur	13·0	12·0 to 13·6

Material examined. On November 31st, 1931, a strange, brown, living mantis was presented to the Museum by Mr. P. Don Ambrose of the Archæological Department, who had captured it at Sigiriya. On 9th December, 1931, she laid an egg-mass, which hatched on 6th January,

1. Later observations show that the change of colour takes place in the course of two or three days after about a month of imaginal life.

1932, and twelve of the resulting larvæ were successfully reared to maturity, which they attained about the middle of March, 1932.

As already indicated, these were all of a predominantly green colouration, and after allowing them about ten days to mature, five males and three females were killed and preserved; two fertilized females were kept alive for breeding and two of the males fell victims to their spouses' cannibalistic propensities.

At this stage in the proceedings I left Colombo for a month, and on my return was surprised to find that both the live females had completely changed colour and now resemble their wild-caught mother. All the bred females are noticeably larger than the mother and their tegmina are more broadly rounded at the apex.

The *type* male and a *paratype* female selected from the bred material will be presented to the British Museum of Natural History on publication of this paper; the remaining paratypes are in the Colombo Museum.

Sub-family **Vatinae**

Cheddikulama gen. nov.

Colour, straw-like. Form, elongate and slender; head carried porrect, broader than long, somewhat pentagonal, rather flattened, behind eyes produced backwards in two angular lobes with a rounded lobe between them. Face short, frontal scutellum transverse, clypeus gibbous. Eyes laterally conical, bearing a small bifid tubercle at their lateral extremity. Ocelli large.

Pronotum slender, with supra-coxal expansion not very pronounced, medially carinate especially in the metazona. Prosternum flattened posterior to coxal acetabula. Fore-coxæ very slightly expanded in the distal portion of the outer carina, their inner distal lobes divergent. Fore-femora slender, their dorsal carina produced at the distal margin into a short angular projection. Unguicular sulcus not far from the middle; four external spines, four discoidal of which the first is at almost a right angle to the others. A circular pit just distal to fourth discoidal for the reception of the terminal external spine. First ten internal spines set alternately one short and one long, then several short ones, then a long one. Outer genicular lobe, only, spinous. Fore-tibiæ with 11-12 external and 14-15 internal spines.

Mid femora carinate, the two ventral carinæ produced distally in a pair of slender, compressed, almost spinous, genicular lobes. Hind femora less carinate than the mid femora, genicular lobes less produced, a small spine on the distal rim of the femur dorsal to the anterior genicular lobe.

Mid and hind tibiæ with traces of carinæ ; each bearing two terminal spurs.

Tegmina self-coloured, well developed but not reaching the end of the abdomen, at least in the female. The costal area slightly expanded basally, with numerous, parallel, very oblique veinlets. Venation tending to be longitudinal, the discoidal vein uniramose, the ulnar triramose ; false veins well developed.

Wings ornate, a large iridescent fuscous blotch in disc of anal area, succeeded by concentric macular bands of the same colour, with, in the middle area of the disc, rows of opaque yellow spots between the bands.

Abdomen slender ; supra-anal lamina transverse, somewhat crenulate on free margin. Cerci short, oval, strongly compressed from base, almost foliaceous.

Genotype : *Cheddikulama straminea* sp. nov., described below. The new genus is monotypic. The female sex only is known.

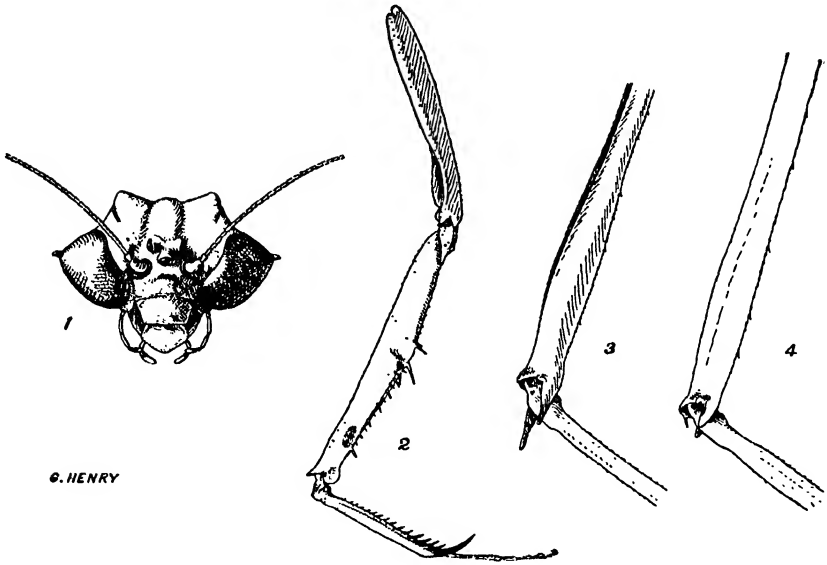
Dr. Uvarov, to whom the description and figures were submitted, states that this genus appears to belong to the Vatinæ in spite of the poorly developed carinæ on the hind tibiæ, and that it probably belongs to a group by itself near *Aethalochroa*. It seems possible, however, that it may be more nearly related to the group Austrovates from North-West Australia. The form of the cerci removes it from the Danuriæ of Africa, with which it seems to show considerable affinity in other respects.

Cheddikulama straminea, sp. nov.

(Plate II, fig. 2 ; Plate V, fig. 2)

Form long and slender, in general appearance resembling dry grass. Head rather large, somewhat flattened, broadly pentagonal, much broader than long, occiput behind the eyes produced into two angular lobes with a rounded lobe between them, the posterior margin concave. Eyes produced laterally ; as seen from in front, mammiform, each bearing a small, slightly bifid tubercle (corresponding to the teat of the mamma) at their lateral extremity. Ocelli large, face short. Frontal scutellum transverse, more than twice as broad as high, slightly arched upward below and above, not carinate ; clypeus somewhat gibbous.

Pronotum long, narrow, with supra-coxal expansion distinct but not very dilated, medially carinate especially in the metazona, its lateral margins denticulate. The prozona somewhat depressed, the metazona semi-cylindrical, deepest shortly before the posterior margin.



Cheddikulama straminea, gen. et sp. nov.

1. Face × 5
2. Right fore-leg × 3
3. Left mid femur × 7
4. Left hind femur × 7

Prosternum behind the coxal insertion flattened, slightly medially sulcate, its margins minutely denticulated.

Tegmina and wings fully developed in the female but much shorter than the abdomen, the former narrow, with costal area somewhat dilated in the basal third, tip sharply and evenly rounded, the venation tending to be very longitudinal. The discoidal vein uniramose, the ulnar triramose; false veins well develped. The tegmina are pale straw-coloured, tending towards hyalinity along the course of the false veins and the posterior discoidal area. Wings shorter than the tegmina, hyaline except along costal area, rose pink at base of anal area (this colour has considerably faded during drying in the unique type), with a large oval blotch of dark brown illuminated with blue and violet reflexions on the disc towards the base; this blotch is followed by broken, concentric bands of the same colour extending nearly to the margin. The spaces between these bands in the middle of the disc are occupied by rows of semi-opaque spots of lemon yellow. In the discal area, each of the spaces between the cross veins in the distal half of the wing contains a dark spot.

Fore-coxæ broader than deep, slightly expanded on the outer margin distally, dorsal surface proximally convex, distally concave,

the outer carina especially well developed and minutely serrate. Their disto-internal lobes are angulated and divergent.

Fore-femora slender, dorsal margin very nearly straight and distally produced into a slightly up-turned, bluntly-pointed lobe ; the unguicular sulcus at about the third seventh from the base. Four external spines, of which the first is three-fifths, third is one-third and fourth is half the length of the second, which is equal in length to about three-fifths of the width of the femur. Four discoidal spines, of which the first is set at almost a right angle to the remainder, which are in a straight line. The third is twice the length of the others, which are nearly equal in length, and is a little longer than the second external. Fourteen internal spines arranged as follows: ılılılılını. A short external genicular spine but no internal. Immediately distal to the fourth discoidal there is a round pit for the reception of the distal external tibial spine when the limb is flexed. A row of small tubercles runs from the base of the femur, in series with the three distal discoidals, then around the inner margin of the pit above-mentioned, and then a little internal to the row of external spines.

Fore-tibiæ with 11-12 external and 14-15 internal spines (not counting the terminal hook).

Mid femora somewhat rectangular in section, slightly incrassated about the distal three-fourths, slightly longitudinally sulcate ventrally, the ventro-posterior carina well developed, minutely serrated ; their genicular lobes produced longitudinally into long, narrow, compressed points. Mid tibiæ with slight carinulæ and a pair of terminal spurs.

Posterior femora much less carinate than the mid femora and scarcely incrassated distally ; their genicular lobes longitudinally produced into semi-elliptic, compressed points much shorter than those of the mid femora. In addition to these points, the outer (anterior) edge of the distal rim of the femur bears a small, but distinct, cylindrical, rather downwardly-directed spine.

Abdomen narrow, slightly expanded at the seventh segment, the ninth with its convergent sides terminating distally in angular points. Supra-anal plate transverse, sinuous at sides, concavely truncate medially.

Cerci short, more or less oval, strongly compressed from the base. (The greater part of them is missing in the unique specimen at hand, but their form was observed in the living specimen before they became damaged).

Colouration : Except for the beautifully coloured wings which have been described above, the whole insect is of a brownish stramineous, clouded here and there with smoky black. There is a mottled dark

brown band across the face at the region of the upper margin of the facial scutellum, and the ocellar region is mottled black. There are cloudy dark brown areas in the following situations: anterior base of fore-coxæ, region of the fore coxo-femoral articulation, region about the unguicular sulcus, a spot at proximal end of femoral brush, indistinct fasciæ on exterior of fore-femora— one a little before the middle, the other just beyond the level of the distal external spine. The pronotum is suffused with brown posteriorly, its posterior lobes being fuscous. The mid and hind coxæ and femora—especially those of the former—have narrow black lines arranged more or less longitudinally in such a way as to accentuate the carinate appearance. The supra-anal lamina is mottled fuscous and the terminal abdominal segments have an indistinct, double, fuscous line down the middle. All these dark markings look very like the sooty fungus that appears on straw that has been exposed to the weather, and heighten the cryptic appearance.

The insect bears numerous minute deep black tubercles rather irregularly scattered almost everywhere. The tegminal veins are sparsely punctuated with minute black spots.

Measurements (Female):

	mm.		mm.
Length of body	69·0	*Width of metazona, maximum*	2·4
Length of head	4·0	*Length of tegmen* ..	35·0
Width of head	5·8	*Width of tegmen (at about proximal fifth)* ..	5·7
Width of frontal scutellum ..	1·8	*Length of wing*	31·0
Length of pronotum ..	19·5	*Width of wing*	14·2
Length of metazona ..	14·5	*Length of fore-coxa* ..	9·0
Width of prozona ..	2·1	*Length of fore-femur* ..	11·5
Width of supra-coxal expansion	3·0	*Length of hind femur* ..	11·0
Width of metazona, minimum	1·9	*Length of hind tibia* ..	13·0

Material examined. Unfortunately, the *type*, a female, is the only specimen available for study. It will be deposited in the British Museum (Natural History) immediately after publication of this paper. It was captured by my Collector, K. L. A. Perera, as a small larva, among roadside grass at Kallar, 3 miles from Cheddikulam, in the Mannar district, on 12-viii-30, and reared to maturity in the laboratory. Its growth was very slow and the last ecdysis took place on 15-iv-31.

Some of its habits are worth recording: it was very seldom seen to eat—or in fact, to do anything voluntarily—and its life during the day, when only it was under observation, was sluggish in the extreme. Its fore-legs were usually carried extended in apposition in front of the head, with their tibiæ fully flexed, and the head was always carried porrect. In this position, among dry grass-straws, it was extraordinarily well concealed, and, even within the limits of a small cage, was

often hard to detect. On several occasions when disturbed it was seen to stiffen itself with its ambulatory legs laid along the body, and allow itself to drop to the ground where it would lie shamming death for a long time. In this position, of course, the straw-like camouflage reached its maximum effectiveness.

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EXPLANATION OF PLATES

Plate I

Fig. 1. *Dysaules uvana* sp. nov. ♀ .... × 1
Fig. 2. Do. ♀ face .... × 4
Fig. 3. Do. ♂ .... × 1
Fig. 4. Do. Ootheca .... × 1¼

Plate II

Fig. 1. *Dysaules uvana* sp. nov. Photograph of living ♀, showing the characteristic resting attitude. A hatched ootheca may be seen on the twig above the insect .. .. .. × 1¼
Fig. 2. *Cheddikulama straminea* gen. et sp. nov. Photograph of living ♀, showing the characteristic attitude .. .. × 1¼

Plate III

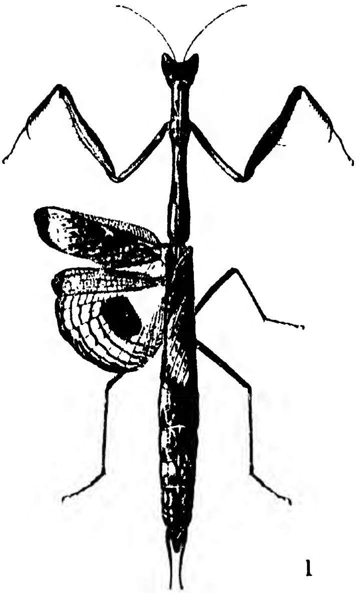
Oxyophthalmus gracilis Sauss. ♀ .. .. .. × 4½

Plate IV

Fig. 1. *Didymocorypha lanceolata* (F) ♀, dorsal .. .. .. × 3
Fig. 2. Do. ♂, lateral .. .. .. × 3

Plate V

Fig. 1. *Hierodula versicolor* sp. nov. ♀ .. .. .. × 2
Fig. 2. *Cheddikulama straminea* gen. et sp. nov ♀ .. . × 1⅕



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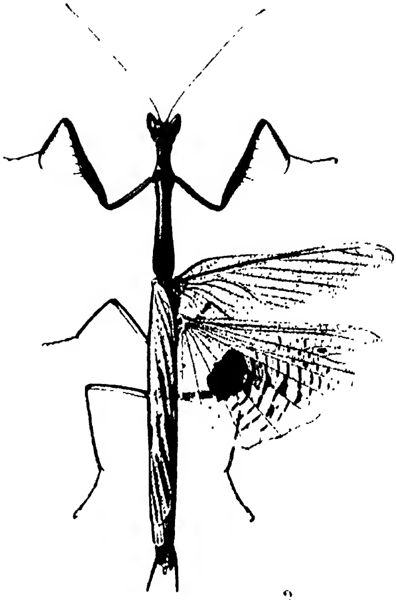

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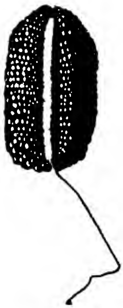

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Dysaules uvana, sp. nov.

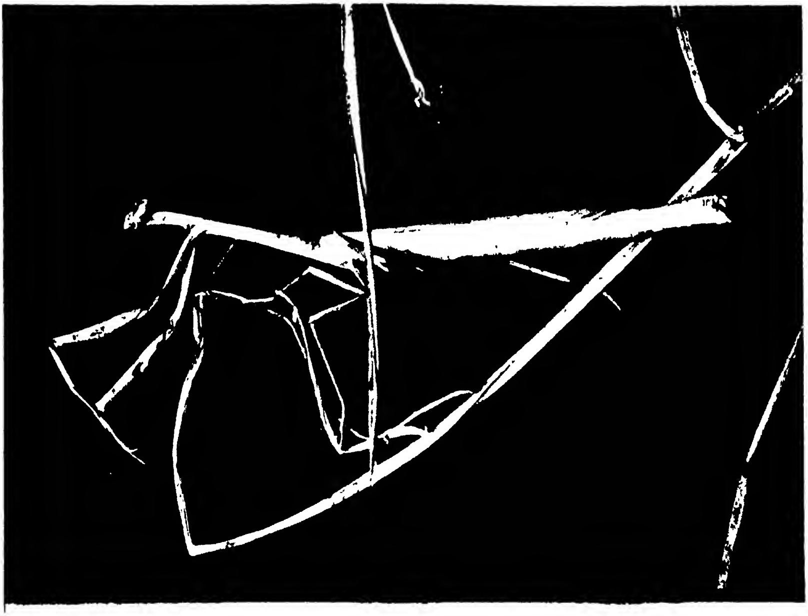


Fig. 2. *Cheddikulama straminea*, gen. et sp. nov.

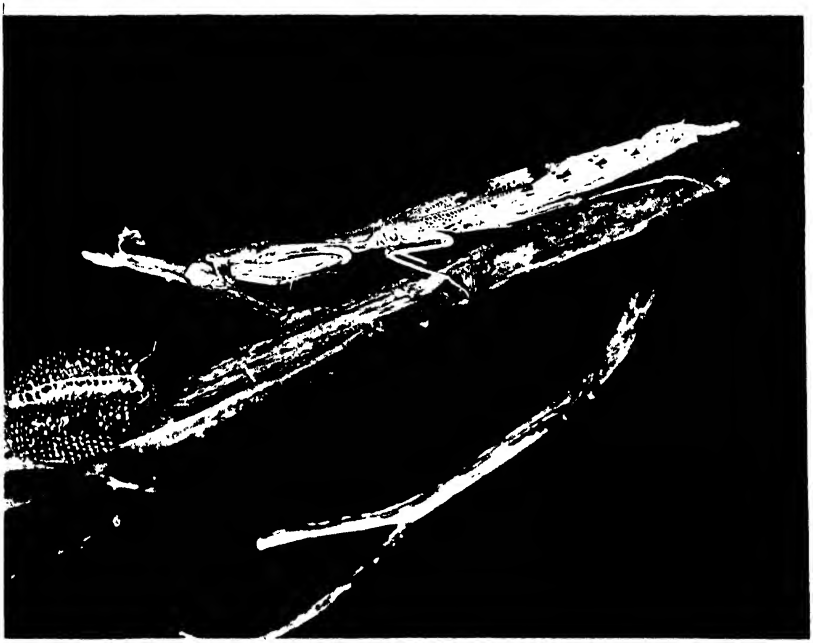
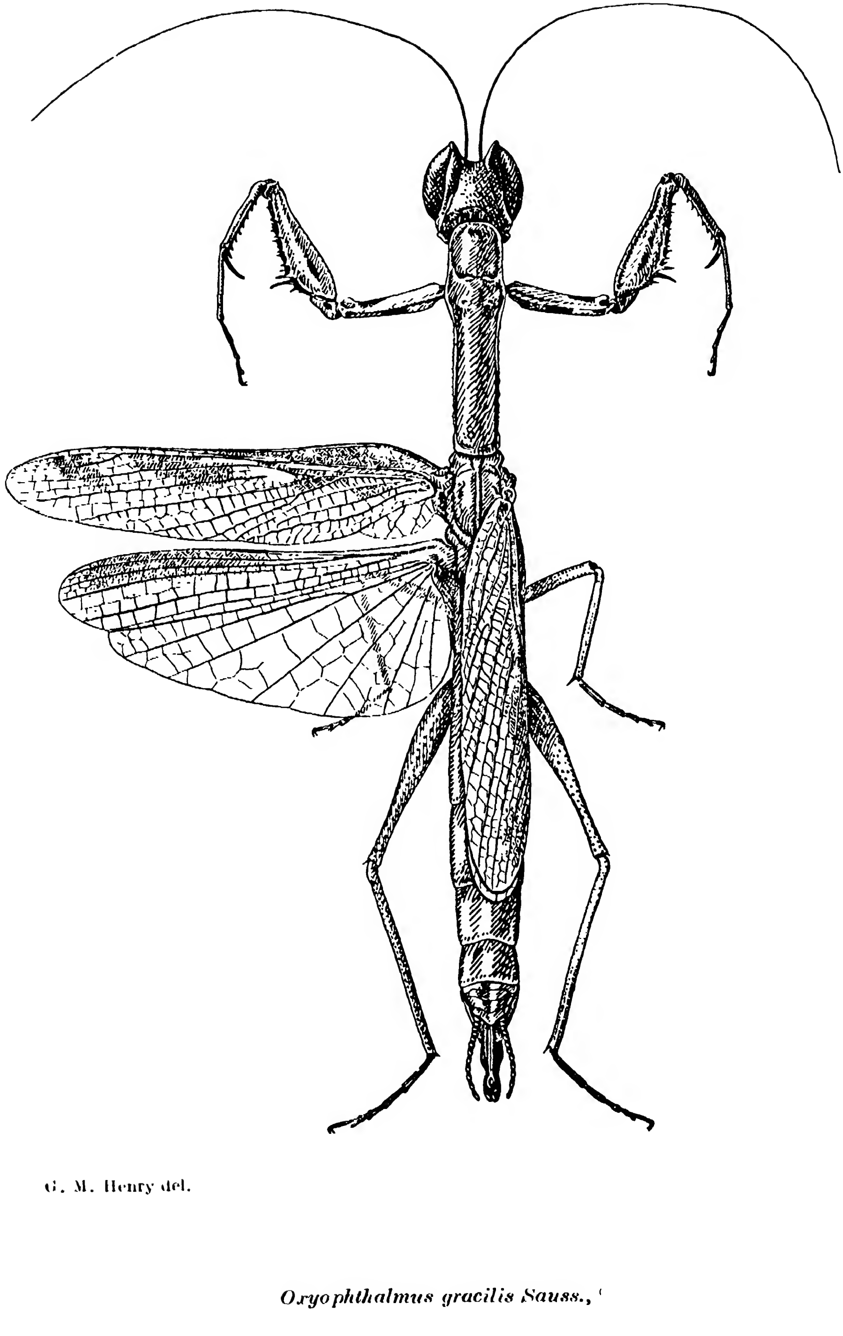


Fig. 1. *Dysaules uvana*, sp. nov.



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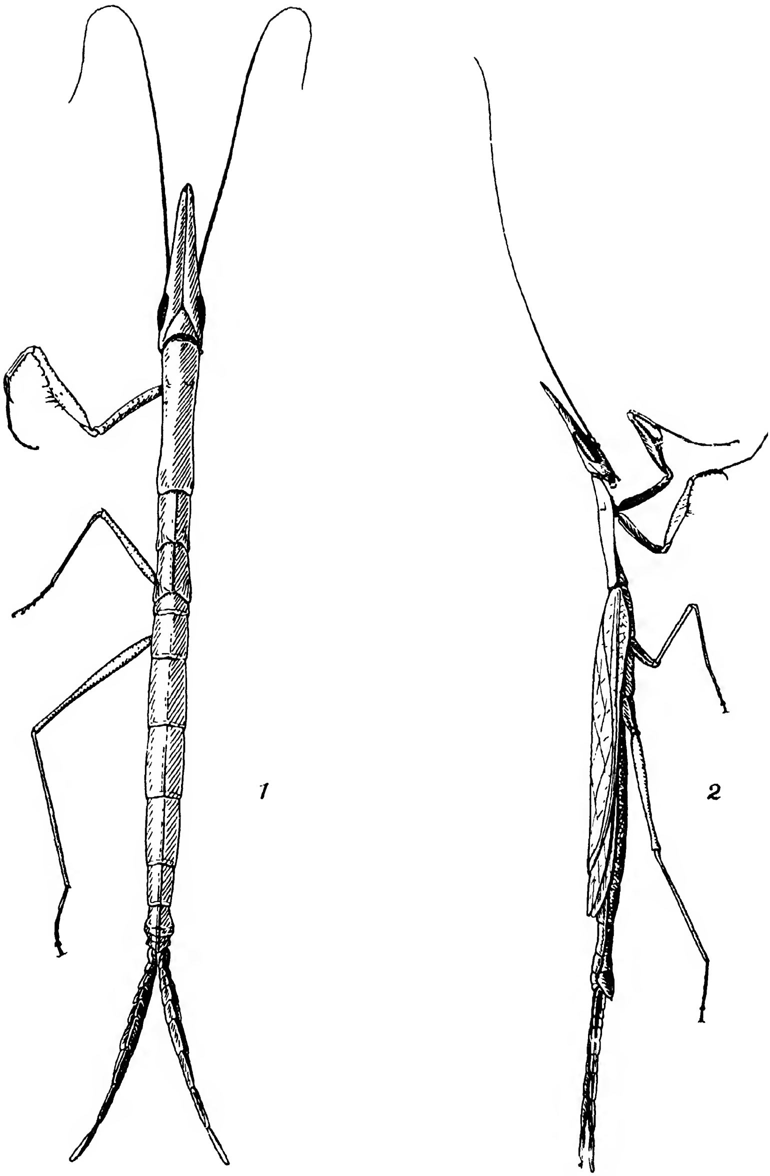
Oxyophthalmus gracilis Sauss., ♀



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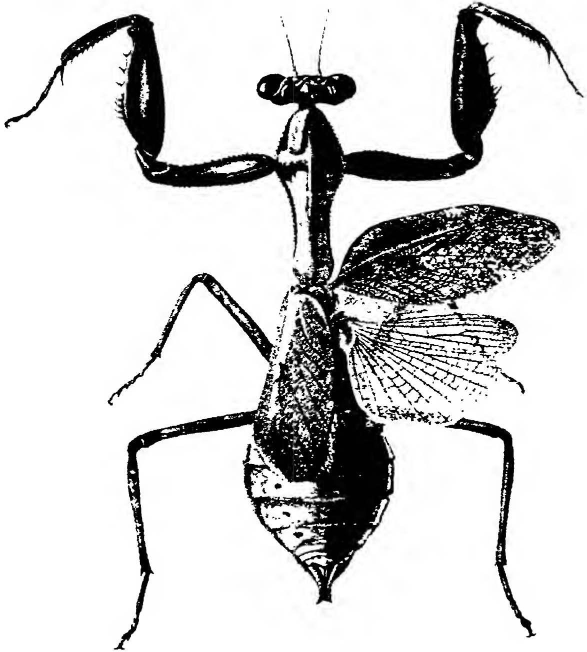
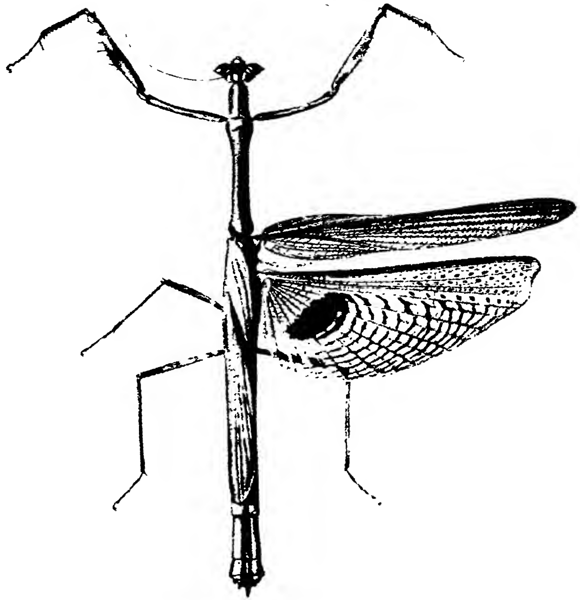
Didymocorypha lanceolata (F

PLATE V





G. M. Henry del.

Fig. 1. *Hierodula versicolor* sp. nov., .

Fig. 2. *Cheddikulama straminea* gen. et sp. nov., ♀.

A New Species and Records of Acrydiinae from Ceylon (Orthoptera, Acrididae)

BY

Morgan Hebard

(With Two Text Figures)

Recently a series of two hundred and eight specimens of Grouse-Locusts was submitted to us for study by the Director of the Colombo Museum. This has proved to include twenty-one species, of which one is described as new. That type is to be sent to the British Museum and the author has retained a duplicate series as is customary.

Little revision was found necessary, but a few genera have been transferred from the position they previously occupied and certain previously overlooked affinities are noted.

The work of Hancock for Ceylon was exceptionally complete for this difficult sub-family,[1] and through the possession of that author's collection we are fortunate in having before us material of all the many species of Sinhalese Acrydines excepting *Cladonotus humbertianus* Saussure, *Cladonotus turrifer* Walker and *Coptotettix testaceus* Bolivar. As a result we are satisfied that Ceylon is far better known as to its Acrydiinæ than most tropical Oriental regions.

Group Cladonotae

Deltonotus humilis Hebard

Deltonotus humilis Hebard, 1929. Rev. Suisse de Zool., 36, p. 568, figs. 1 and 2. [♂, ♀; Valparai, Anaimalais and Elkhill, Nilgiris in Southern India.]

Urugala, 17.iv.1924 (Woodside), 1 ♂; Mousakande, Gammaduwa, 5 and 6.xi.1929, 2 ♂ 1 ♀.

1. Hancock, 1904. "The Tettigidae of Ceylon," *Spolia Zeylanica, II., pp. 97 to 157.*
1908. "A new Ceylonese Tettigid (Orthoptera) of the genus Eurymorphopus," *Spolia Zeylanica, V. pp. 113 and 114.*
1910. "Notes on Ceylonese Tetriginae (Orthoptera) with descriptions of some new species," *Spolia Zeylanica, VI, pp. 140 to 148.*
And some scattered data in Trans. Ent. Soc. London, 1907 and 1909; Mem. Dept. Agr. India, Ent. Series, IV, 1912, and Records Indian Mus., XI, 1915.
Other literature is this section of Kirby's "Fauna of British India," 1914 and in 1929 our "Acrydiinae of Southern India" *Rev. Suisse de Zool., XXXVI*, cleared up several of the remaining problems concerning species found in Ceylon.

These specimens agree closely with a female paratype in the author's collection, differing only in having the pronotal surface distinctly less rugoso-pustulate (though distinctly rougher than in *D. subcucullatus*). Incipient racial differentiation may be indicated.

Deltonotus cristatus Hancock

Hantane, iii.1903, 1 ♂, 1 ♀, *type* and *allotype*, 1 juv. ♀ (Hebard Cln.). Ohiya, iv.1929, 1 ♀. Haputale, 4,700 feet, 17.vi.1926, 1 ♀.

We placed this name as a synonym of *D. subcucullatus subcucullatus* (Walker) in 1929, and it is true that a pair from Pundaluoya have the pronotum more produced over the head than the others. The material now before us, however, shows so little variation and is so distinct from typical *subcucullatus* that we believe it best to recognize a species rather than a race.

Hancock barely described this insect.[1] It is nearest *subcucullatus subcucullatus*, differing in the slightly less strongly tectate pronotum, with cephalic portion projecting to above the eye (to just beyond the eye in Pundaluoya pair). The caudal extremity of the pronotum has its margins convex to the sharply rounded apex as in *cucullatus*, except in the Haputale female in which it is broadly rounded with the bilobation there found in *humilis* vaguely suggested. In size and depth of pronotum it is about intermediate between *subcucullatus subcucullatus* and *humilis*.

Group **Scelimenæ**

Scelimena gavialis Saussure

Deniyaya, 20.ix.1923, 1 small juv. ♂.

A series of immature individuals of this common species is before us. In the earlier instars the pronotal lateral lobes are rectangulate produced, a spine appearing there only in the later instars. This is here found to be true also for immatures of *Eucriotettix tricarinatus* and we believe it safe to say that this is a rule for all species so spined. Observance of this will aid the student in avoiding description of the largest of such immatures as brachypterous new species. The danger with females is slight as sharp teeth are always present on the ovipositor in the adult, but in males careful observation is sometimes necessary. As we stated in 1929 Kirby erected not only specific but a generic synonym in 1914, based on such material. Had he noted

1 1907. Trans. Ent. Soc., London, 1907, p. 216.

the immature character of the organs of flight those mistakes would not have occurred.

Eucriotettix spinilobus (Hancock)

Ratnapura, 17.ix.1929, 1 ♂. Kitulgala, 8.iv.1927, 2 ♀. Wellawaya, 30.xii.1927, 1 ♂. Labugama, 20.i.1930 and 9.iii.1931, 2 ♂, 1 ♀. Balangoda, 30.iv.1926, 1 ♀. Colombo, 2.ii.1929, 2 ♂.

The pronotal lateral lobes have the spine evenly curved forward in all these specimens.

Eucriotettix tricarinatus (Bolivar)

Twelve males, twenty-one females and three immature individuals of this common species, the adults all caudate, are from Labugama, Mihintale, Colombo, Wellawaya, Belihuloya, Kanniyai, Kudaoya, Rakwana, Kandy, Kallar and Ingiriya.

More attenuate and averaging prominently larger than *spinilobus*, this species is sometimes subject to considerable size variation. One female of five from Kudaoya, a male and one of two females from Colombo, the single female from Ingiriya and two of four males from Mihintale are decidedly smaller than the others and in size are indistinguishable from the average in *spinilobus*.

Thoradonota spiculoba (Hancock)

Kandy, 2 to 5.iv.1926, 1 ♀ (abbreviate).

Criotettix miliarius (Bolivar)

Battaramulla, 14 and 26. iii. and 7.v,1930 ; ix.1927, 4 ♂, 6 ♀.

Hancock's *miliarius cuneatus* is a synonym, based on material with pronotum abbreviate, as shown by the type in the author's collection.

One male has the pronotum abbreviate, one has it subcaudate, the other specimens have it caudate.

Loxilobus acutus (Hancock)

Colombo, 14.ii, 9 and 25. iii, 1926 to 1930, 3 ♂, 2 ♀ (caudate). Battaramulla, 11 and 26.iii, 9,vi. and ix, 1927 to 1931, 4 ♂, 4 ♀ (caudate). Galle, 4.v. 1907 (T. B. Fletcher), 1 ♂ [Hebard Cln.].

Group Metrodorae

Systolederus greeni Bolivar

Belihuloya, 4.ix.1928, 2 ♂. Labugama, 30.v.1931, 1 ♂. Madugoda, 12.iv.1930, 1 ♀.

Mazerredia insularis Bolivar

Madugoda, 13.iv.1930, 1 ♀, 1 juv.

The genus *Mazarredia*, as noted by us in 1929, is polyphyletic. When the species, and particularly the Philippine genotype *gemella* Bolivar are better understood, it is quite possible that *insularis*, in spite of its having scarcely subrectangulate projections of the pronotal lateral lobes (instead of spines as in the type of *Lamellitettix*) will be found to belong to *Lamellitettix* Hancock. Indeed comparison shows that *insularis* agrees in more features with the Sinhalese *L. pluricarinatus* Hancock[1] than with any species of *Mazarredia*.

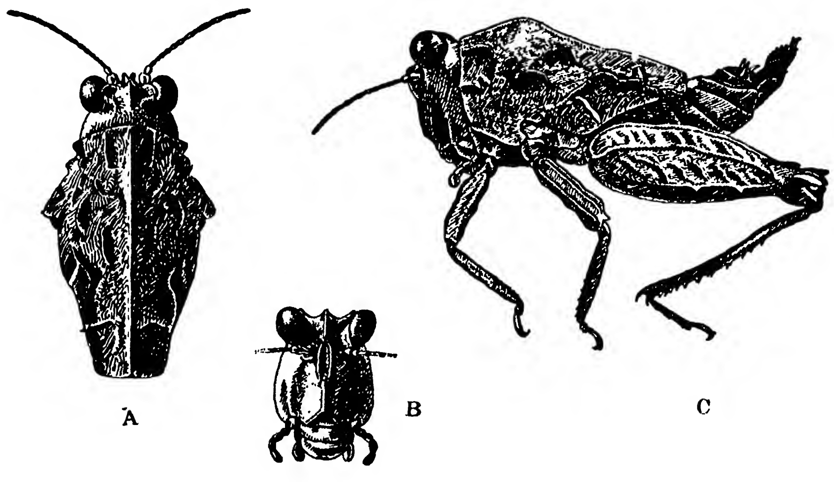


Fig. 1—*Amphinotus pygmaeus* Hanc. ♀

A. head and pronotum, dorsal view × 7. B. face × 7. C. whole insect, profile × 7.

Amphinotus pygmaeus Hancock. (Text fig. 1)

Ohiya, 6,500 feet, 30.iv.1928 and iv.1929, 2 ♂, 1 ♀. Hakgala, 21.viii. 1929, 1 ♀.

1. The angles of the pronotal lateral lobes are more produced in *Lamellitettix pluricarinatus* than in *Mazarredia insularis*, but not as much as in the Bornean *Mazarredia centrosa* Bolivar.

Cingalina gen. nov.

Nearest *Amphinotus* Hancock, these genera agree in being very small and apterous: the vertex wide, bifossulate cephalad and submammate caudad ; the frontal costa suddenly produced for some distance between the antennae, rather widely forked ; the ocelli situated briefly above the antennal sockets ; antennae comparatively short and inserted just below eyes ; pronotum subtectiform in cephalic portion, median carina prominent throughout, humeral angles absent, lateral lobes with rounded angles moderately flaring ; caudal metatarsus nearly twice length of third tarsal joint.

The present genus is distinguished as follows : Vertex with lateral carinæ scarcely extending beyond eyes, leaving a wide space to median carina ; eyes not at all subpedunculate ; pronotum with cephalic margin feebly obtuse-angulate produced, tectation gradually lessening caudad, lateral carinæ decided and parallel on prozona, two short conspicuous carinæ at shoulders and two similar but curved carinæ between them with median area between the latter raised ; limbs stout, shorter than in *Amphinotus* ; cephalic and median femora with margins undulate and an angulate projection mesad on their ventral margin ; caudal femora with two denticles on ventro-external carina (sometimes absent in female).

Cingalina salebrosa sp. nov. (Text fig. 2)

This minute, short species shows purely superficial general resemblance to the two scabrous brachypterous species which have been assigned to *Coptotettix* and which we mention under that genus. The very different vertex and frontal costa, hirsute limbs and smooth caudal femora are a few of the numerous features which distinguish them.

Type : ♂; Nuwara Eliya, Ceylon. 12.v.1927. [British Museum.]

In addition to the characters given above the following are valuable. Size smaller than female, form robust. Fastigium twice as wide as eye ; its lateral carinæ short, straight, slightly convergent to its non-carinate transverse distal margin beyond which projects the strong medio-longitudinal carina ; fastigio-facial juncture evenly convex in lateral aspect, the frontal costa forming a decided obtuse-angulate emargination with its flattened-convex interantennal projection. Eye no deeper than wide. Lateral ocelli opposite basal third of eye but, due to the great width of the vertex, the area from them to it is decidedly wider than deep. Pronotal surface tuberculate and with very coarse but low nodes and very strong but short carinæ, lateral margins with a decided convexity above point where the humeral angles would be

situated if such existed ; caudal portion broadly truncate, leaving apex of abdomen exposed. Tegmina and wings absent.

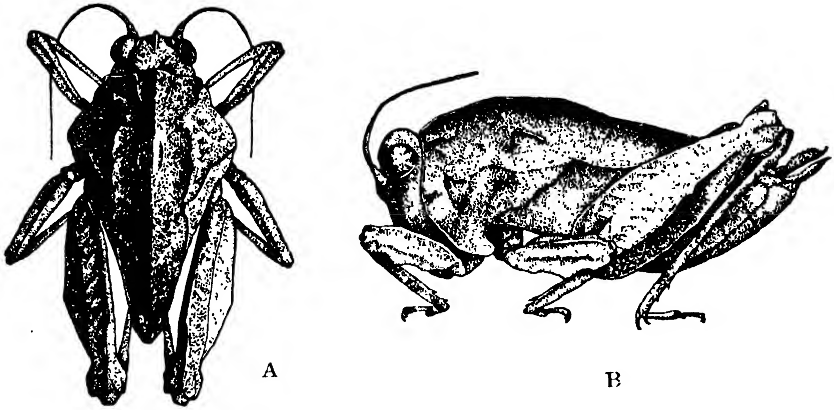


Fig. 2.—*Cingalina salebrosa*, sp. nov.
A.—Dorsal view of male, type. × 7½. B.—Lateral view of female, allotype. × 7½.

Allotype : ♀; same data as type but taken 31.vi.1924. [British Museum.]

Agrees in ambisexual characters, differing from male in being larger and more robust with carinæ and nodes prominent, but not as strongly defined, except the projections of the caudal femora which are more prominent than in that sex.[1]

In the immatures the carinæ, rugæ and projections are all more elevated and sharper than in the adults, this giving them a closer superficial resemblance to *Amphinotus pygmaeus*.

General colouration dark, individually prouts brown or mummy brown. Caudal tibiæ black with a meso-proximal and a meso-distal broad annulus of buffy. Though usually very conspicuous, these annuli are weak or obsolete in specimens where the caudal femora are paler, brown, or light brown. In the allotype patches of slightly paler brown are present on the pronotal lateral lobes, across the pronotum caudad and the caudal femora, this extended to include the entire dorsum in the Ohiya female and very weak and confined to the caudal femora in the Hakgala female.

The measurements of the type and allotype are given first. Length of body ♂ 5·4, 5·8 ; ♀ 6·8, : interocular width ♂ 0·68, 0·65 ; ♀ 0·80, 0·75 : length of pronotum ♂ 4·4, 5 ; ♀ 5·1, 5·3 : width of pronotum

1. Individually variable, however, as they are obsolete in the Ohiya female.

at apices of lateral lobes ♂ 2·95, 3·02 ; ♀ 3·34, 3·34 : width of pronotum at caudal extremity ♂ 0·75, 0·85 ; ♀ 0·92, 0·92 ; length of caudal femur ♂ 4, 4·1 ; ♀ 4·7, 4·7 mm.

Specimens examined : 8 ; 3 males, 3 females and 2 immature individuals.

Nuwara Eliya, 12.v.1927, 2 ♂, *type* and *paratype* ; 31.viii.1924, 1 ♀, *allotype*.

Kandapola, 23.ix.1926, 1 ♂, *paratype*.

Hakgala, 20.viii.1929, 1 ♀, *paratype* ; 24.viii.1929, 1 juv. ♀.

Ohiya, 6,500 feet, 28.iv.1928, 1 ♀, *paratype*.

Pidurutalagala, 28.vii.1924, 1 juv. ♀.

Apterotettix obtusus Hancock

Ohiya, iv.1929, 1 juv. ♂, 1 juv. ♀.

Though representing a much more simple phylum, we believe that this genus should precede *Spadotettix* in linear arrangement. Though the vertex is not unusually produced, the retreating face is a striking feature in this smooth, abbreviate species.

Spadotettix fletcheri Hancock

Madugoda, 12.iv.1930, 1 ♂.

This, the first known male, differs from the type only in the smaller size, very slightly narrower fastigium, very slightly smoother and less undulate pronotum. In both sexes the cephalic femora show a very weak short convexity of the ventral margin mesad.

Male. Entire length of body 6·7, length of pronotum 5, length of caudal femur 4·1 mm.[1]

Group Acrydiae

Euparatettix personatus (Bolivar)

Colombo, iii. and xi, 1924 to 1927, 4 ♂, 2 ♀. Maha Oya, 25.vii. 1929, 1 ♂, 1 ♀. Mihintale, 7 to 9.vii.1927, 1 ♂. Sigiriya, viii.1909, 1 ♂ [Hebard Cln.]. Ratnapura, 18.ix.1929, 1 ♂. Kitulgala 8 and 11.iv.1927, 3 ♂. Panadure, 14.iii.1925, 1 ♀.

Though correctly recorded by Hancock from Peradeniya and Kesbewa in 1904 and from the former locality and Kandy in 1915, that author's series so recorded from Hambantota actually represent *E. variabilis*.

1 The caudal femur measures 4·9 mm. in the type, not 4 as given by Hancock.

Euparatettix variabilis (Bolivar)

Wellawaya, 30.xii.1927, 3 ♂. Balangoda, 15.iv.1926, 1 ♂. Horawupotaña, 7.x.1924, 1 ♂. Mihintale, 7 to 9.vii. 1927, 1 ♂. Trincomalee, 11 and 14.vii.1927, 10 ♂, 6 ♀.

The larger size and caudal tibiæ not or much less conspicuously pale annulate proximad are features of value in separating this species from the closely related *personatus*.

Ergatettix dorsifera (Walker)

This species was recorded from Weligama as the synonymous *Euparatettix pilosus* by Hancock in 1910.

Colombo, 21. i, 13. ii, and 12.x.1926 and 1929, 1 ♂, 3 ♀. Wellawaya, 30.xii.1927, 1 ♂. Trincomalee, 11.vii.1927, 2 ♂, 3 ♀, 1 juv. Bibile, 26.vii.1929, 1 ♀.

Paratettix cingalensis (Walker)

The tremendous variation in size, colour and degree of pronotal production in this common species has led to a numerous synonymy.

Eleven males, twenty-three females and one immature are from Bandarawela, Battaramulla, Lunugala, Ohiya, Ratnapura, Balangoda, Deniyaya, Wellawaya, Colombo, Ingiriya, Hakgala and Rakwana. Of these six males and thirteen females have the pronotum abbreviate, one male and four females have it subcaudate to different degrees and four males and six females have it caudate.

Genus **Coptotettix** Bolivar

The relationship of this genus to *Hedotettix* Bolivar was originally recognized. The close agreement of these genera in form of vertex and frontal costa with *Loxilobus* Hancock has, however, decidedly more significance in our opinion than has previously been indicated. A detailed revision of the Acrydiinae may associate these genera in close proximity, but although now placed in different groups we feel that so radical a step can not be taken at the present time.

The vertex is distinctive in having the lateral carinæ convex-convergent to different degrees and normally fading out before the median carina is reached ; the frontal costa projecting in such a way that it and the large lateral ocelli are conspicuous from above.

We have studied the many species referred to these genera before us and find that among them the species renamed *Loxilobus hancocki* by Kirby, which was originally described as *Criotettix rugosus* by

Hancock from Ceylon, must be transferred to *Coptotettix*. No characters indicating generic separation from the genotype, *Coptotettix asperatus* Bolivar, can be found.

In describing these genera Bolivar in 1887 gave a series of characters, many of which have little or no generic diagnostic significance and some of which are highly misleading. It is evident that this occurred because these, like so many other genera as then understood, were polyphyletic or included some species belonging actually to distinct genera, and his generic diagnoses were drawn from all the species included and not from a genotype or only such species as were definitely congeneric with it.

The following key gives the major features by which we believe they may best be distinguished.

A.—Pronotal lateral lobes horizontally angulate or spiniform produced.
Loxilobus Hancock.

AA.—Pronotal lateral lobes deflexed, rounded, appearing feebly or not produced from above.

B.—Pronotum with cephalic margin never obtuse-angulate produced. Dorsum not cristate, medio-longitudinal carina weak and becoming irregular caudad.[1]
Coptotettix Bolivar.

BB.—Pronotum with cephalic margin transverse or obtuse-angulate produced. Dorsum cristate or with medio-longitudinal carina slightly compressed and percurrent.
Hedotettix Bolivar.

The species *Coptotettix fossulatus* Bolivar and *Coptotettix parvus* Hancock with short heavy hirsute limbs may prove to be generically distinct. This is even more probable for *Coptotettix pusillus* Hebard, a species agreeing with them in that feature but with vertex very differently lamellate produced. Though even more definitely a member of the Acrydiae than the others, *pusillus* approaches more closely *Apterotettix obtusus* Hancock in vertex and frontal costa.

Coptotettix rugosus (Hancock)

Hancock suggested the present generic association in 1909.
Kurunegala, 20.v.1929, 1 juv. ♂.

Hedotettix attenuatus Hancock

Colombo, 11.i,13.ii, and 24 and 27.vi.1929, 2 ♂, 6 ♀. Kitulgala, 7.iv.1927, 1 ♂. Bibile 26.vii.1929, 1 ♂. Maha Oya, 25.vii.1929, 1 ♂.

1. Except in *capitatus* Bolivar.

Hedotettix gracilis (Haan)

Maha Oya, 25.vii.1929, 1 ♂ (caudate). Wellawaya, 30.xii.1927 and i,1928, 2 ♂, 7 ♀ (caudate). Kitulgala, 7 and 12.iv.1927, 1 ♂, 1 ♀, (caudate). Colombo, 24.vi.1929, 1 ♀ (subcaudate). Badulla xii.1928, 1 ♀ (subcaudate).

The Venation of the Wings of the Leaf-insect, Pulchriphyllium crurifolium

BY

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(With Two Plates and Two Text Figures)

The Phasmidae and Mantidae are the two families of the Orthoptera in which the venation of the wings has not been studied. The Phasmidae present many peculiarities, for many genera are wingless or have reduced or vestigial wings in one or both sexes. The leaf-insect, however, possesses wings in both sexes, and this work may be regarded as a *point d'appui* for the study of the family.

The leaf-insect, *Pulchriphyllium crurifolium* Serville, exhibits a marked sexual dimorphism in respect of size, antennae, wings and power of flight. The male (Plate VI, fig. 2), which is capable of flight, is small, with long antennae and with its hind wings fully developed, the tegmina being reduced to small vestiges, while in the female (Plate VI, fig. 1) the antennae are short and possess a stridulating organ, the hind wings are rudimentary, and the fore-wings although fully formed are ineffectual as organs of flight. The sex can be distinguished in the nymphal instars after the first, for the primordia of the wing-buds can be seen from the second instar onwards, and the relative lengths of the meso- and meta-thoracic wing-buds differ in the male and female. The male has five instars, while the female has seven, but as the rate of growth is almost the same in each case it would appear that the larger size of the female is due to a prolonged nymphal condition.

When at rest the fore-wings of the female lie flat along the back, their straight anal margins slightly overlapping, generally left over right. The wings are lightly locked together, the interlocking mechanism consisting of the raised media and cubitus of the right wing being held by the bent-down anal margin of the left wing.

The main longitudinal veins are concentrated in the anal margin and branch outwards after the manner of the veins arising from one side of the mid-rib in a plant leaf. As it is unusual to find veins in this condition it was thought that the wings had developed in an inverted position as they do in the saltatorial Orthoptera and had retained this developmental condition in the imago. A study of their ontogeny, however, shows that this is not the case, and that the tracheation of the nymphal wing-buds, and the venation of the wings are normal.

The part played by the costa in the wings of the Orthoptera is a disputed point, and unfortunately its presence or absence is regarded by some writers as a diagnostic character of the families of the Orthoptera, and in this work an attempt is made to determine the homologies of the veins and to elucidate the problem of the costa in the leaf-insect.

TECHNIQUE

The method generally employed in studying tracheation of nymphal wings depends on the tracheae remaining visible on account of the air contained in them when they are mounted in glycerine jelly. This necessitates rapid manipulation and recording of data immediately after preparation, as the tracheae soon become filled with the mountant and are thereby rendered invisible. This method was employed in many cases in addition to a method involving the injection of the tracheae with rubber latex and the subsequent coagulation of the latex to rubber, which method gave more permanent preparations. In the first method, the wing-buds with a part of the thorax were dissected off, rapidly cleared in a mixture of glycerine, caustic potash and alcohol, mounted in glycerine and photographed. In the second method, the thoracic segments were dissected off with their legs and wing-buds and washed in dilute caustic soda. They were then placed in a vessel containing rubber latex preserved in a fluid condition by the addition of ·5 per cent caustic soda, and this vessel was put in a bell-jar attached to a vacuum pump. On starting the pump the air was drawn out of the tracheae and bubbled out of the latex. When the latex exhibited no more bubbling the pump was stopped and air was allowed to enter the bell-jar slowly, the increase in pressure causing the latex to be forced into the empty tracheae. The preparation was then removed from the latex, the adhering latex was carefully washed away with water, and it was allowed to stand in 20 per cent acetic acid for a few hours to enable the acid to penetrate and coagulate the latex in the tracheae. The preparation was then cleared in glycerine, the parts required dissected off and mounted in glycerine jelly, and in some cases

where the chitin was pigmented they were decolourised in 20 per cent caustic soda which had no apparent effect on the coagulated latex.

In determining the nymphal instar, the body-length was taken, as during each stadium the body length varies within but small limits. The following table gives the average length of each instar in the male and female :—

Instar		*Length of female (mm.)*		*Length of male (mm.)*
1	..	15·7	..	15·7
2	..	21·4	..	21·8
3	..	27·8	..	28·3
4	..	38·5	..	39·5
5	..	49·5	..	48·0 (imago)
6	..	66·2		
7	..	88·0 (imago)		

DESCRIPTION

The female wings

In the following descriptions the nomenclature adopted is that of Comstock (1918), which is in almost universal use.

Fore-wings

In the wing-buds of the fore-wings all the tracheae may be clearly seen from the fourth instar onwards. The wing-buds in the fourth, fifth and sixth instars differ only in the greater development of the net-work of cross-veins, the cross-veins showing the same arrangement in the last nymphal instar as in the imago (Plate VII, fig. 1). The tracheae present are the subcostal, radial, medial, cubital and anal, and although they show in different individuals certain variations in their branches, their arrangements are very similar and their basal connections are identical.

Basal connections. The anterior trachea supplying the wing-bud, the costo-radial, arises from the dorso-lateral trunk which sends an anterior branch to the meso-thoracic leg, and the posterior trachea, the cubito-anal, is also continuous with the dorso-lateral trunk which is connected with the meso-thoracic spiracle, and which sends a posterior branch to the meso-thoracic leg. There is, therefore, no inversion of the treacheae inside the wing. The transverse basal trachea is always present uniting the costo-radial and cubito-anal tracheae. In every case studied the medial trachea has migrated towards the cubital, the origins of these two tracheae being contiguous, while the radial trachea has its origin close to the subcostal.

Costal trachea. It is impossible to distinguish a costal trachea, unless this is represented by the first main branch of the subcostal trachea which is almost uniformly present. In one or two cases (Plate VII, fig. 6) there are two tracheae lying close together in the usual position of the subcostal trachea where it was thought hat the anterior might be the costal, but as the second trachea has its origin in the main radial trunk this is obviously not the case, and the second is a branch of the radial trachea. As there is frequently an additional radial branch which varies in its position (Plate VII, fig. 3), this case can be regarded as an extreme case where the first radial branch lies close to the subcostal trachea. In no wings studied has it been shown that a costal vein exists, all evidence is against it, so that the anterior vein of the wing, which is not marginal in position must be considered as the subcosta.

Radial trachea. The radial trachea runs obliquely backwards from its point of origin to give off its two branches (which correspond to radius 1 and the radial sector), which run towards the costal margin, roughly parallel to the subcostal trachea. The radial trachea is normally two-branched, except in these few cases where there is an additional branch, variable in its position behind the subcostal trachea. The normal type of branching is seen in Plate VII, figs. 1, 2, 4 and 5, where there is a single main trunk which divides into two, but in Plate VII, fig. 3, the two branches are separate throughout their entire extent from the point of origin of the main radial trachea.

Medial trachea. The medial trachea is likewise two-branched, its basal trunk runs parallel to, and alongside the radial trunk, and its two branches, lying distal to the radial branches, form two parallel tracheae. The medial trachea has its origin close to that of the cubital. In a few cases, however, it is unbranched as in Plate VII, fig. 3.

Cubital trachea. As a rule the cubital trachea is unbranched, and from its origin close to that of the medial trachea, continues parallel to it, extending to the apex of the wing. In two cases only were the cubital tracheae two-branched, the two branches lying side by side throughout their extent (Plate VII, figs. 3 and 6).

Anal trachea. There is one anal trachea arising a short distance behind the origin of the cubital trachea and extending for about one-third of the wing a short distance from the anal margin.

The peculiarity of the wing lies in the position of the main tracheal trunks close to the anal margin, while their branches, approximately parallel to one another, run obliquely outwards the costal margin. The variation in the branching of the tracheae is reflected in the fact

that the wings have ceased to function, and in the principle that an organ which has ceased to have a functional significance tends to vary.

No difficulty arises in determining the homologies of the veins of the imaginal wings, as they can be referred directly to the tracheae of the nymphal wing-buds.

Hind wings.

The hind wings of the female are rudimentary and appear as atrophied wing-buds. There are a few tracheae in them but their homologies have not been determined.

The male wings

Fore-wings (tegmina).

The fore-wings of the male, the tegmina, are small and scale-like and of the texture of parchment but they possess the principal wing veins, more apparent however in the wing-buds of the fourth or penultimate nymphal instar. The tracheae are not branched as in the hind wing or the female fore-wing (Text fig. 1).

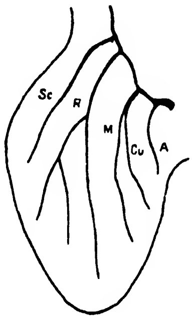

Fig. 1—*Pulchriphyllium crurifolium.* Wing-bud of tegmen of male nymph, fourth instar.

Basal connections. As in the case of the female fore-wing the dorso-lateral trachea forms the basal transverse trachea of the wing, branches arising at the anterior and posterior margins of the wing supplying the meso-thoracic leg. Subcostal, radial, medial, cubital and anal tracheae are present, the medial trachea having migrated towards the cubital trachea, uniting with it basally.

Wing tracheae. The tracheae of the third and fourth instars show the same arrangement. There is a single subcostal trachea lying a short distance from the costal margin, a two-branched radial trachea, the second branch of which reaches to the tip of the tegmen, a single medial and a single cubital trachea united at their bases, and a single anal trachea. Occasionally the radial trachea shows a third branch in the fourth instar (Text fig. 1).

Hind-wings.

The hind wings resemble, in many respects, those of the saltatorial Orthoptera, in so far as they possess an enlarged anal area, which when at rest is folded fanwise (Plate VI, fig. 2). The line of demarcation, separating the folded anal region from the rest of the wing is a single unbranched cubitus.

Basal connections. A basal trachea is found in the wing-bud of the hind wing, as in the fore-wing and in other Orthoptera, and the position of the medial trachea arising from it is nearer to the cubital trachea than to the radial (Text fig. 2).

Subcostal trachea. No distinct, separate costal trachea is found, the anterior trachea of the wing-bud, which is not a marginal vein in the adult, being identified as the subcostal trachea. The subcostal trachea is well developed and extends almost to the tip of the wing. In every case studied it was single and unbranched, except for small branches running towards the costal margin, and lay a short distance from the costal margin parallel to it.

Radial trachea. Lying close to the subcostal trachea the radial trachea extends to the tip of the wing following the curvature of the costal margin, and unites at the apex with the single cubital trachea. A radial sector is given off distally, curving posteriorly and outwards. It unites in the imaginal wing with the medial and cubital tracheae, and in some wing-buds this connection was made out.

Medial trachea. There is a difference in the relation of this trachea in the hind wing to that found in the fore-wing, for whereas in the fore-wing it is united basally to the cubital trachea, in the hind wing it arises between the radial and cubital tracheae, very near the latter. There are two main branches of the medial trachea, both branches running towards the cubital trachea and uniting with it in the imaginal wing.

Cubital trachea. This trachea varies greatly in other Orthoptera. In the Blattidae there are generally many accessory branches; in the Saltatoria great variations are found, for in the typical form there are

two branches which form part of the fan-like anal area, while in the Acridiidae it is single. In the nymph of the leaf-insect there is a single main trachea which marks off the anal area, and which, running to the apex of the wing, bends forwards to unite with the first branch of the radial trachea to form a loop.

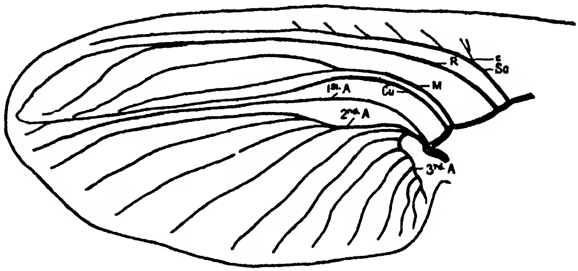

Fig. 2.—*Pulchriphyllium crurifolium.* Wing-bud of male nymph. Penultimate instar.

Anal tracheae (Text fig. 2). There are two distinct anal trunks with a common origin in the basal transverse trachea. The first of these is unbranched, undoubtedly representing the first anal trachea. The second trunk divides into twelve branches which represent the second and third anal tracheae, and these radiate outwards forming the ribs of the fan-like anal area of the wing, The two anal trunks arise a considerable distance behind the cubital trachea. The first radial trachea, towards the middle of its course, lies close to the cubital trachea, but distally it bends backwards, where the cubital bends forward to unite with the radial, running straight to the margin of the wing. From a consideration of the branching of the second trunk it is possible to identify the second and third anal tracheæ. The first anal trachea is definitely unbranched, the next four branches arise from a single branch of the second trunk, while the remaining tracheae arise in succession from the distal border of the second branch of the second trunk which bends sharply at right angles from its origin and continues along the inner margin of the anal angle. The anal tracheae are therefore divisible into three groups, identified as the first, second and third anal tracheæ. In other Orthoptera it has only been possible to identify the first anal trachea, which is never branched, and the second and third which are represented by a single stout stem dividing into many branches. In the Acridiidae, however, or in *Œcanthus* the separation of the second

anal trunk into second and third anal tracheæ is seen, although in a much less definite manner than in the leaf-insect.

DISCUSSION AND CONCLUSIONS

The first salient point with regard to the wings is the modification of the female tegmina to the semblance of a leaf with the principal veins lying close together along the anal margin. To the absence of any functional significance of the female tegmina is attributed the variation in the veins and tracheae in the wings of the same and different individuals. To this fact also is attributed the variation in actual size of the imaginal wing which was encountered—in some specimens the length was only half that shown in Plate VI, fig. 1. From an examination of over a hundred specimens the arrangement seen in Plate VII, figs. 1, 2, 4 and 5 would appear to be typical.

The fore-wing of the male is modified, the modification taking the form of reduction in size and simplification of venation.

The only truly functional and apparently least modified wings being the hind wings, it would appear that any comparisons with other insects must be made with regard to the characters exhibited by these.

In the hind wings (and also in the fore-wings) the media has migrated towards the cubito-anal trachea. In the fore-wing of the Blattidae the media belongs to the costo-radial group, and in the hind wing of that family it occupies, as a rule, an intermediate position, while in the saltatorial Orthoptera its position is uniformly close to the cubito-anal group. The leaf-insect likewise resembles the saltatorial Orthoptera (particularly the Acridiidae) in the condition of the cubitus and in the mode of branching of the anal tracheae. Bearing in mind that it is not possible to draw conclusions applicable to a whole family from the study of one member, one can do little more than point to the differences and similarities. With regard to the costa, the evidence from this study points to its absence in the leaf-insect. The most anterior vein of the tegmen or wing is named the subcosta—as it is not marginal in position; as the manner in which the accessory veins arise from it running towards the costal margin is precisely that of the subcosta in fossil insects of the Orthoptera type; and as this name is the only one which enables the remaining veins to be named rationally and according to the veins of the accepted generalised wing.

Handlirsch (1908) divided the Orthoptera into Orthoptera (Saltatoria), Phasmoidea (Phasmidae), Mantoidea (Mantidae), and Blattoidea (Blattidae), the first two of which he placed in the sub-class Orthopteroidea and tde latter two in the sub-class Blattaeformia. Without discussing the merits or demerits of this system one can point to the

resemblance of the leaf-insect to the saltatorial Orthoptera and its dissimilarity to the Blattidae, or, in other words, it resembles more the saltatorial group than the cursorial group in which it is generally placed (Sharp, 1898). Here again Handlirsch identifies the Orthopteroidea as having the costa distant from the wing-margin, but whether we name the first vein the costa or subcosta, its position in the leaf-insect is distant from the wing-margin.

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DESCRIPTION OF PLATES

PLATE VI

Pulchriphyllium crurifolium 6/5. 1—female, 2—male.

PLATE VII

Nymphal wing-buds of *Pulchriphyllium crurifolium*. ♀, sixth instar (penultimate), taken directly from microphotograms, 6.

1. Wing-bud, showing typical arrangement of tracheal net-work
2. Wing-bud, showng typical arrangement of tracheae, tracdeal net-work omitted.

3. and 4. Left and right wing-buds of same individual showing variation on each side, particularly accessory branches of radial and cubital tracheae on left side (3).

5. and 6. Left and right wing-buds of same individual showing variation on each side, and particularly double cubital trachea on right side (6) and accessory branch of radial trachea lying close to subcostal trachea.

Tracheae lettered as follows :—

Sc.—subcostal, R=radial, R_1—first radial, Rs=radial sector, M=medial, M_1=first medial, M_2=second medial, Cu—cubital, Cu_1=first cubital, Cu_2=second cubital, A—anal

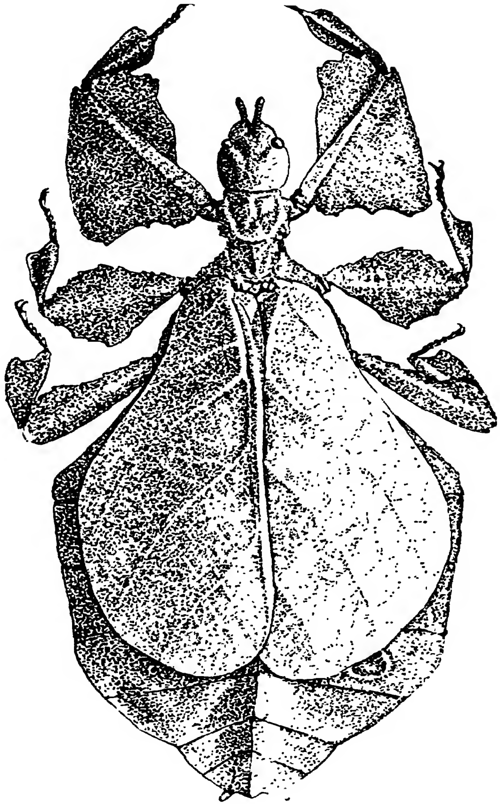


Fig. 1

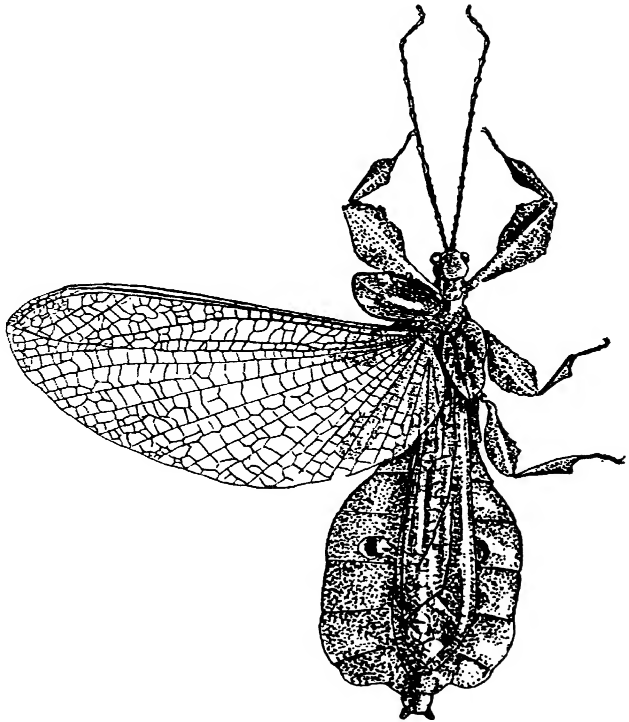
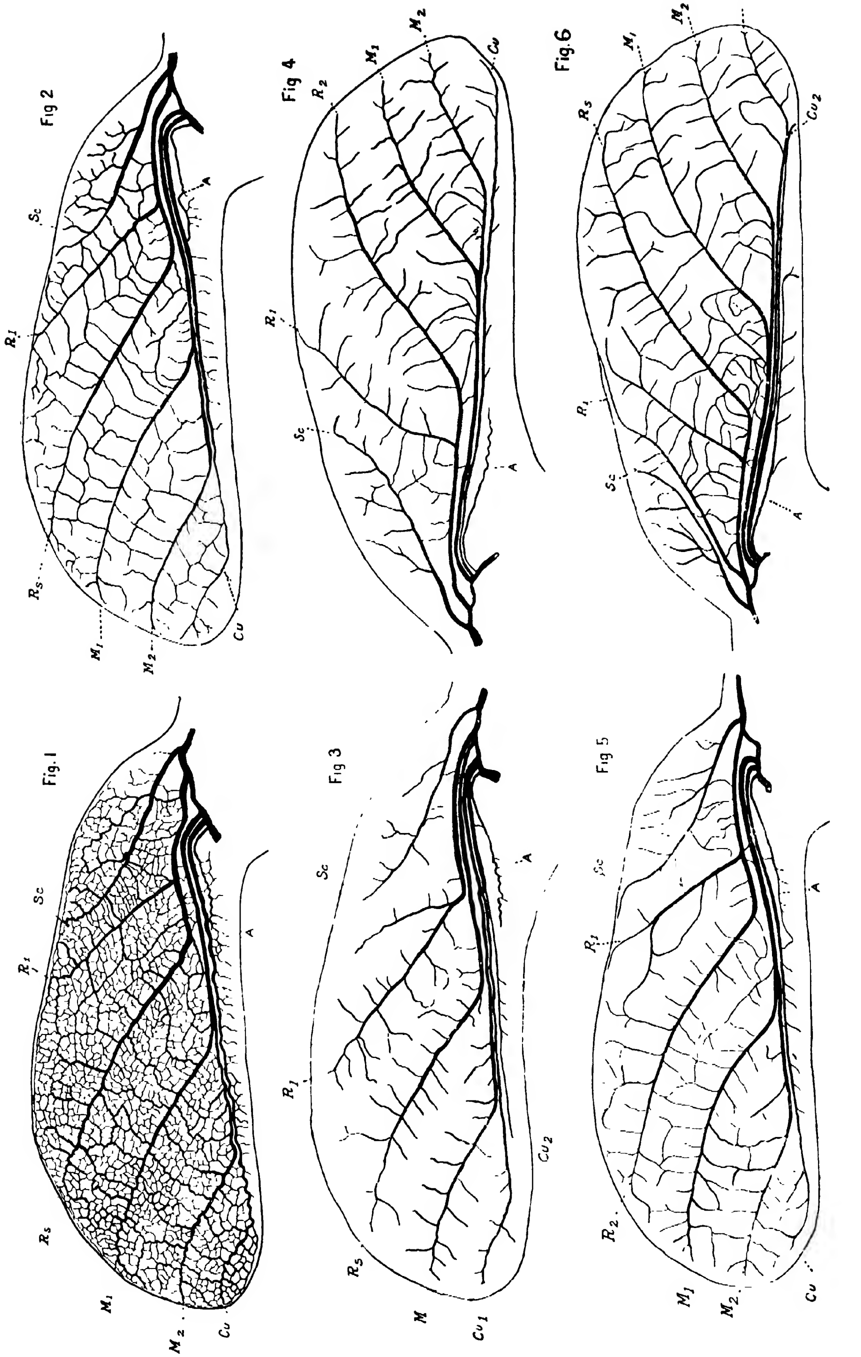


Fig. 2

Pulchriphyllium crurifolium



Nymphal wing-buds of *Pulchriphyllium crurifolium*

Notes

1. Notes on Ceylon Snakes

Uropeltis grandis. A specimen of this rare Ceylon snake was received from Passara. The snake had a brilliant dark purple blue sheen when first received, but this colour disappeared after the snake had been in formalin solution for two weeks, when it became a uniform dark brown dorsally and lighter ventrally.

The snake measured 1 foot 7¼ inches (490 mm.) which is 1¼ inches longer than the maximum length given by Wall (1921).

The snake has a curious shape. Just behind the head it is arched for about one-fifth of its length and here it has great muscular development, so that its greatest width (28 mm.) is situated about 40 mm. behind the head. The maximum width of the posterior half of the body is 22 mm.

The caudal shield measures 23 mm. by 20 mm. The shielded part of the head measures 16 mm. The rostral shield shows some signs of keeling which is absent in small specimens of this species.

Rhinophis oxyrhynchus. Mr. Carter has collected a specimen which measures 24¼ inches (615 mm.) : the previous recorded maximum is 22½ inches.

Ophites aulicus. A specimen of this species was received from Galle, it measured when received 2 feet 9½ inches (850 mm.).

Dendrophis caudolineolatus. A number of specimens of this snake have been received from Mousakanda, East Matale. The longest specimen is a gravid female measuring 36 inches (915 mm.).

A point of interest is the extreme variability of the loreal scales. In one batch of five specimens received, two had one loreal on each side of the head ; two had a narrow loreal on one side of the head, and on the other side the loreal was fused with the prefrontal scale which extended down to the labials ; the fifth specimen had no loreals as the fusion with the prefrontals had taken place on both sides. More recently I have received another specimen which has no loreal scales. Werner (1909) described a new species of Dendrophis from a single specimen received from Colombo, and named it *D. effrenis*. It differed from *D. caudolineolatus* in two respects, viz., the absence of loreals and in possessing 175 ventrals. The greatest number

of ventrals recorded by Wall for *D. caudolineolatus* is 161 ; the greatest number of ventrals which I have seen on a specimen of this species is 166. It is doubtful whether a difference of nine ventral scales is sufficient to justify the establishment of a new species, and therefore Wall's suggestion that *D. effrenis* may prove to be an aberrant specimen of *D. caudolineolatus* is probably well founded.

Bungarus ceylonicus. A very fine specimen of this krait was received from Mousakanda, East Matale, it measures 43 inches (109·cm.), Boulenger gives the maximum length as 39¾ inches.

Bungarus caeruleus. This has generally been considered to be a very rare snake in Ceylon. But during the last two years I have received fourteen specimens from Mr. Spencer Schrader, who is a proprietor of a coconut estate in the Negombo area. They were found at different times under coconut leaves and debris. It may be that a small colony flourishes on this estate, but it is more probable that this krait is common on other coconut estates.

It is generally considered that specimens of this snake over four feet in length are unusual, and the maximum length given by Wall is 4 feet 7 inches.

Mr. Spencer Schrader on 13th March, 1931, sent me a specimen measuring 55 inches (139·7 cm.) and fourteen days later he forwarded another which measured 55½ inches (141·0 cm.).

A few weeks later I received from him an albino specimen. It measured 39¾ inches (101·0 cm.) and except for the irises it was pure white without a trace of black pigment. A few of the ventral scales, however, showed patches of yellow pigment.

L. NICHOLLS.

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2. Ichthyological Notes

The Systematic position of the genus Channa

In a recent paper, Myers and Shapovalov (1932) draw attention to the fact that the two fishes *Ophicephalus gachua* Ham. Buch. and *Channa orientalis* Bloch and Schneider, agree more or less in fin rays, head shields, scales, colour, pyloric caeca and dimensions and only differ in that the former possesses ventral fins, whereas the latter has none. They also quote Day's statement that " It is not uncommon

in India to find specimens of *Ophiocephalus gachua* having a ventral fin deficient but I have never observed both wanting."

In view of this evidence they submit that "it seems reasonable to *suspect* that *Channa orientalis* may be nothing but a series of anomalous specimens of *O. gachua*, a species which in certain streams of Ceylon, more than elsewhere, shows a tendency to lose its pelvic fins."

In the course of investigations into the fresh water fishes of Ceylon, no evidence has been obtained to confirm the suggestion that the Ceylon form of *O. gachua* shows a tendency to lose its ventral fins, hence there does not appear to be anything to support the view that these two forms, which are identical save in the single important exception of the ventral fins, are in effect one and the same species.

It is usual for members of a brood of young Ophicephalids to remain together for some time in company with the parent fish. If it were the case that the ventral-finned form, *O. gachua*, tended to lose these fins we should expect some evidence of this variability from an examination of these consanguineous broods.

Three such broods consisting of 45, 128 and 69 individuals respectively, have been examined and in every instance the young fish had normal ventral fins. Two small collections taken from two broods of *Channa orientalis* which were with the parent showed no signs of ventral fins. One collection consisted of seven individuals, the other of five.

It must be admitted that the problem requires further investigation, for we may be dealing with a pair of mendelian allelomorphs and the presence of ventrals in *O. gachua* which is the commoner form may be dominant to the absence of these fins in *C. orientalis* which is comparatively rare. If the two are proved to be conspecific then the name *Channa* Scopoli, replaces *Ophicephalus* Bloch, as suggested by Myers and Shapovalov. If, however, each of the two fishes in question is distinct, in view of the similarity between the two in other respects, the generic status of *Ophicephalus* should be lowered to that of a subgenus of *Channa*.

It is necessary that this question be examined further and it is proposed to make an intensive study of these two forms with a view to settling an important and interesting problem.

Some mineral spring fishes

Cuvier and Valenciennes (1842) were the first to describe thermal spring fishes from Ceylon. The fishes were collected by M. Reynaud in 1830 from the hot springs at Kanniyai in the Eastern Province. The

temperature of the water was given by him as 50° C. and in accordance with this information the specific name of each fish implied its heated habitat.

They were named *Leuciscus thermalis*, *Ambassis thermalis*, *Nuria thermoicos*, and *Cobitis thermalis* which are to-day known as *Puntius thermalis*, *Ambassis thermalis*, *Esomus danrica thermoicos* and *Lepidocephalus thermalis* respectively.

Strange to say three collections made by me in 1926 and 1928 yielded only one of Reynaud's forms and three others which although common here and elsewhere in Ceylon, have not been recorded from these springs. These fishes are—

Lepidocephalus thermalis (Cuvier et Valenciennes)

Rasbora daniconius (Ham. Buch.)

Ophicephalus gachua (Ham. Buch.) and

Eleotris fusca (Rüpp.)

Both *Lepidocephalus thermalis* and *Ophicephalus gachua* were abnormally dark and the former were larger than those found in cooler water further from the source. *O. gachua* was a young specimen, purplish brown in colour with an ocellus on the dorsal fin, a mark commonly found on this fish when young.

The last collection was made at 8 a.m. on September 19, 1928, at a distance of thirty yards from the source where fishes first appear and where the temperature of the water was 36·5° C., while water cooler than 32° C. was neglected. The air temperature at that time was 26·5° C.

The temperature of the spring near the exit of the enclosure showed 40·75° C. as taken by me, and the water at the outlet to the enclosure was 39·5° C.

The absence of several of the forms taken by Reynaud induced me to examine the types of *Leuciscus thermalis* when in Paris in 1930. There are three specimens marked No. 3,364 in the Museum d' Histoire Naturelle and they were all *Puntius chola*, a very common Ceylon fish. Their description by Cuvier and Valenciennes who state that the lateral line in incomplete is entirely erroneous as each possessed a complete one of 24 perforate scales. Dr. Jacques Pellegrin who very kindly permitted me to examine the specimens, agreed with my identification and an entry was made in the Museum catalogue that *Leuciscus thermalis* was a synonym for *Puntius chola* (See Deraniyagala, 1930).

Maha Oya (E.P.) was the next hot spring examined. The water at the source was too heated for the naked hand to bear. Collections were made at thirty yards from this point. The first capture which consisted of young *Rasbora daniconius* was made at a temperature

of 37·5° C. and water cooler than 35·5° C. was neglected. This collection was made at 10.12 a.m. on April 6th, 1931, when the air temperature was 32·3° C.

The fishes were *Amblypharyngodon melettinus* (Cuv. et Val.) which was present in large shoals and was somewhat more slender in body than usual.

Laubuca (Laubuca) laubuca (Ham. Buch.)
Lepidocephalus thermalis (Cuv. et Val.)
Puntius vittatus Day, *Puntius bimaculatus* (Bleeker) and
Rasbora daniconius (Ham. Buch.).

The chalybeate spring of Bibile was examined on April 7th, 1931. The temperature was comparatively normal, being 28·6° C. with the air temperature at 26·2° C.

The fishes taken were *Rasbora daniconius* (Ham. Buch).
Lepidocephalus thermalis (Cuv. et Val.)
Puntius bimaculatus (Bleeker)
Ophicephalus gachua Ham. Buch., and
Amblypharyngodon melettinus (Cuv. et Val.)

The collections show that these fishes do not live in water exceeding 37·5° C. and even then they are scarce, although they abound in water with a warmth of 35·5° C.

It is also noteworthy that the larger species of *Puntius* and *Esomus danrica thermoicos* have not been seen or taken by me from warm water.

A rain of fishes

Fishes are well-known to be taken up by water spouts and later deposited alive together with the rain and such occurrences have been reported several times from Ceylon. Tennant (1861) was one of the earliest to mention them from Galle and Colombo, while Pearson (1929) in dealing with the subject at some length referred to a rain of fishes and frogs which occurred at Kalutara South in 1929. The clerk of the Kalutara Basket Association saw thirty *Anabas testudineus* fall from the sky and according to the local papers several hundreds of this fish and a host of tiny frogs were scattered near the Basket Hall and the fishes were gathered into bags by women. It is well-known that this fish which has an accessary air breathing apparatus can travel on land and it was thought that the fishes had left their pond during the rain.

On July 24th, 1931, a heavy shower lasted from 10 to 11 a.m. and directly afterwards a caretaker of the Colombo Turf Ciub brought a small can full of living *Rasbora daniconius* 62 to 70 mm. long which

he asserted fell upon the cinder track of the racecourse from the clouds. I immediately despatched the laboratory assistant to ascertain whether other species were present. He returned in twenty minutes and said that all the fishes were *Rasbora daniconius* and that there were plenty on the cinder track. There is no pond close to the racecourse and even if this had been the case *Rasbora* is unable to travel across land as do the *Labyrinthici*, *Anguillidae*, and some *Eventognathi*.

It is interesting to note that in each case only one species of fish was found. This needs some explanation. Rasbora does swim in shoals and it is possible that such a shoal was taken up by the water spout. Anabas however, does not swim at the surface in shoals, although colonies do inhabit ponds where individuals rise to the surface from time to time. It is remarkable that the other fishes which doubtless lived with the Anabas were not noticed by the observers who comment merely on this fish and small frogs.

P. E. P. DERANIYAGALA.

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3. Herpetological Notes

Reptiles and fish associates

The association of certain small carangoid fishes with larger marine animals such as sharks, turtles and whales has been known from very early times. The ancients supposed that these fishes piloted the larger animal toward food, and also warned it of impending danger and were recompensed for their services by particles that floated off during its meal. While this is probably correct there is also another aspect which hitherto has received little attention. This is that the fishes are coprophagous and are attracted mainly by the excreta of the animal they follow. This is a habit not uncommon to fishes and several such as the young of the eel *Ophichthus apicalis* (Deraniyagala, 1932) *Vandellia cirrhosa* and Fierasfer actually enter the cloacal cavities of other animals.

On February 22, 1932, while accompanying the divers on pearl bank inspection in the Gulf of Mannar a large specimen of the sea snake *Hydrophis stokesi* 150 cm. long was seen swimming lazily at the surface. Four small carangoids each five or six cm. long with yellowish sides

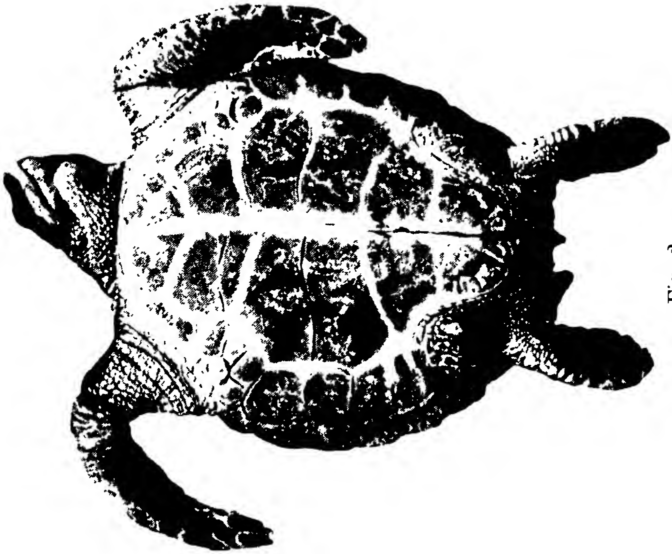

Fig. 2.

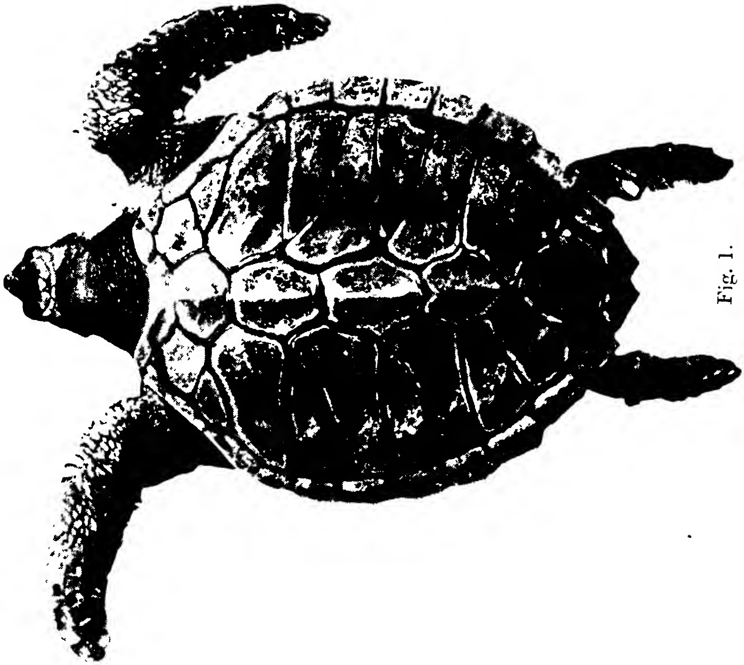

Fig. 1.

Caretta with 9 pairs of costal scutes

Fig. 1. Carapace. Fig. 2. Plastron.

and dark olive cross-bands kept up a position immediately below the snake's cloaca. As the boat approached closer, the fish scattered but soon returned and resumed their former position. Eventually the snake was killed by a blow with an oar.

On February 24, 1932, a female *Dermochelys coriacea* was taken six miles off Colombo in wide meshed drift nets. Its carapace length along the neural ridge was 159 cm. During its examination the fishermen remarked on a fish which persistently accompanied the turtle dashed in and out of the wide meshes of the net and finally took refuge between the carapace and hind flipper of its enmeshed associate and was captured with it. On inquiring for the fish they produced a pilot fish *Naucrates ductor* 165 mm. long, exclusive of the caudal fin.

The Pilot fish is known to follow large marine animals but it has been thought that this association was in order to obtain particles of food which float off when its associate secured a meal. However, the hiding place selected indicates that this choice of shelter may have been influenced by the coprophagous nature of the fish.

Scutes of the loggerhead turtle (Plate VIII)

Dr. Malcolm Smith (1931, p. 71) states that Caretta has five to eight pairs of costal scutes. On the other hand, I have stated that there were five to nine such pairs (Deraniyagala, 1930*a*). This was based on an examination of embryos and newly hatched young in which this nine-scute condition is rare. Plate VIII shows such a specimen. It was obtained on January 18, 1930, by Mr. D. G. Andriesz at Galkissa (W.P.) when it emerged from the nest as a newly hatched specimen. It is now two years and three months old and its measurements are :—Head length 80 mm., carapace length 320 mm., carapace width 300 mm., plastral length 265 mm., axilla to groin 139 mm. The colour is a dingy olive green dorsally with a pale yellow plastron. The carapace scutation consists of five vertebrals, nine pairs of costals and thirteen marginals on each side (Plate VIII, fig. 1). The plastral scutes are normal (Plate VIII, fig. 2) and there are four inframarginal pores on each side and two claws on each limb. Some workers are inclined to regard any scutes in excess of five as mere "split-offs." Elsewhere (Deraniyagala, 1930*b*) I have endeavoured to explain why costal scutes which are in excess of five should not be so regarded, and have also shown that a scute which varies within the species by possessing these so-called "split-offs" is really a composite scute formed by the fusion of several ancestral scutes which reappear in some individuals as an atavistic throw-back and resolve the scute into its components.

Egg and embryo of Lyriocephalus (Text fig. 1)

Kelaart (1852) states that *Lyriocephalus scutatus* (Linné) lays three or four hard-shelled eggs as large as those of a sparrow. This appears to be one of several errors in his herpetology. On December 9th, 1931, Mr. W. W. A. Phillips sent the writer a large soft-shelled egg from Gammaduva (3,000 ft.) where Lyriocephalus abounds in the cardamom bushes. This egg had evidently been washed out of the soil by the heavy rain of the previous day. It measured 24 by 15 mm. and contained a well formed embryo. Pigment had just begun to appear, as a double lateral row of six ellipsoid spots from neck to hips, of these the upper were the larger. The eyes were protuberant and an annular eyelid had begun to form. The pupil was surrounded by twelve placode-like thickenings, rudiments of the sclerotic plates. There was no external tympanum and the fourth digit of each limb was longer than the others. The two hemipenes protruded and the tail was short and cylindrical narrowing suddenly at its tip. There were a few scattered tubercles on each side of the body.

Fig. 1. Embryo of *Lyriocephalus scutatus*.

The measurements of the embryo were as follows :—Curved length 15 mm., length of head 7·5 mm., axilla to groin 5·5 mm., tail 9·5 mm., depth of body 4 mm., depth of head 6·5 mm., depth of eye 4·5 mm. Four features stamped this as the embryo of Lyriocephalus. The absence of the tympanum, the presence of lateral tubercles, the elongate fourth digit and the short tail which later becomes compressed and strangely enough resembles an aquatic adaptation although the lizard is sub-arboreal and restricted to the hill country. It lays four eggs.

Calotes embryos show a large tympanum and a tail nearly twice as long as the body and an embryo showing incipient pigmentation had the head and body 13 mm. long with a tail of 24 mm.

Reproduction of Acontias (Nessia) layardi (Text fig. 2)

Most skinks are supposed to be ovoviviparous but oviparity appears to be common in Ceylon forms. The species *Mabuya macularia* Blyth, *Lygosoma (Sphenomorphus) taprobanensis* Kelaart, and *Lygosoma (Riopa) punctata* (Linné) are oviparous. The last named is uncertain as no eggs have been obtained outside the body of the female. To this number is now added *Acontias (Nessia) layardi* Kelaart. This form which is fossorial is almost limbless, having four vestiges, of which the anterior pair are mere thickenings surrounded by five or six small scales, while the posterior ones are two stumps set with minute scales, and are located on each side of the cloaca. The ear is also minute and placed eight scales behind the eye, while the fore-limbs are twenty-one to twenty-three scales behind the ear and separated from each other by six interpectoral scales. The eggs which vary in size, are white and elongate with pointed ends and are excessively soft-shelled, for the egg case is very thin and flaccid, a feature of help in identifying the egg. I am indebted to Mr. W. W. A. Phillips of Gammaduwa for all the specimens dealt with in this note. He says that the eggs were found in a small new clearing surrounded by heavy jungle on a hill side (altitude 3,400 feet). They were buried in silt lodged behind some stone terracing and were some inches below the surface which consisted chiefly of dark jungle soil.

Four batches of eggs were examined and were found to vary considerably in size ; those with embryos were turgid and noticeably thicker than newly laid ones which were markedly flaccid. An interesting feature is that the eggs seem far too large for so slim bodied an animal as Acontias[1] and are more like the eggs of an Agamid lizard.

1. For figure, measurements and description, see Deraniyagala, 1931.

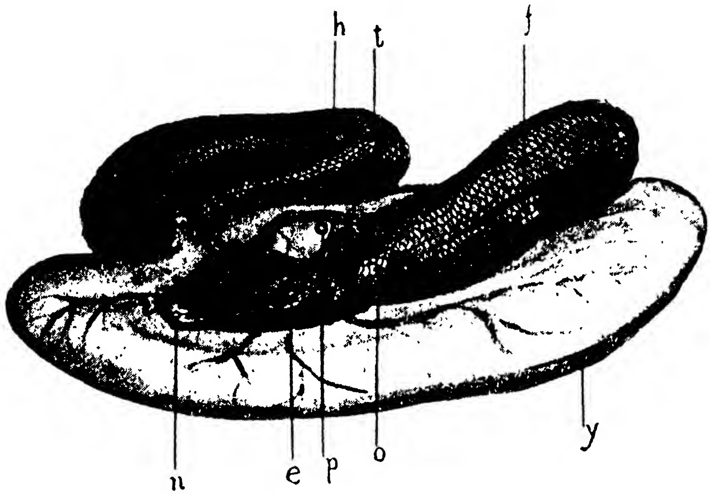

Fig. 2. Embryo of *Acontias* (*Nessia*) *layardi*

e=eye, f=fore limb, h=hind limb, n=nostril, o=ear, p=pineal organ, y=yolk, t=tip of tail.

A specimen taken at Gammaduwa on March 9th, 1932, laid an egg 16·5 by 7 mm. on March 19th. This was buried in the earth by the mother which lived under the surface.

On April 4th, 1932, a female 130 mm. long was sent along with three eggs ranging from 16 to 16·5 mm. by 8 mm. This was captured by a workman when in the act of laying.

On April 29th, 1932, Mr. Phillips sent down two eggs, one 21 by 9·5 mm., the other 21 by 11 mm., both contained advanced embryos which were well pigmented. The dimensions of one specimen were as follows :—Snout to fore limb 10 mm., snout to cloaca 40 mm., tail 14 mm., umbilicus to cloaca 8 mm. The animal was on its left side so that the head and anterior part of the body lay on the yolk, the tail was curled up and passed under the umbilical stalk. Its tip ended near the left hind limb. The vitelline veins and arteries went out in two strands over the right flank. The head and pectoral region was thicker than the rest of the body. Lepidosis was complete, the ear hole well defined, while the vestigial fore and hind limbs showed as small light coloured areas. These limbs on examination were similar to the adult condition and were each surrounded by five or six small scales. The ear was eight scales behind the eye and had a bifid scale anteriorly, the anterior limbs were twenty-one to twenty-three scales behind the ear. There were six interpectoral scales between the fore-limbs. The limbs were minute thickenings. The hind limbs were

located on each side of the cloaca and were distinct prominences covered with minute scales. Although the embryos were so advanced there was no trace of a rostral point for bursting the egg covering. Possibly the fine flaccid egg case is easily ruptured without such an aid.

Four eggs sent on May 4th, 1932, were 17 by 9, 18 by 10 and 16 by 10 mm. The embryos were younger than the previous ones, and the body and tail was coiled in a helicoid spiral between the yolk and egg cover. The dimensions of an embryo are snout to cloaca 30 mm., tail 11·5 mm. Lepidosis was complete but the scales were not fully imbricate and had black pigment at their centres.

A prominent feature was the circular pineal organ at the posterior angle of the interparietal scale. This consisted of two black concentric circles of which the inner was the thicker, enclosing brownish inter-spaces. Underneath this organ ran a vein as was noted in the living embryo. The body colour of the embryo was hyaline and the blood circulation and action of the heart were visible. The hemipenes were extruded.

Fontanelles in the hawksbill turtle

In the Testudinata of Ceylon (1930*a*) the writer described the carapace of an adult female *Eretmochelys imbricata* taken at Bentota (S.P.) on February 16th, 1928, where it laid 115 eggs. The carapace was 770 mm. long. The scutes were completely juxtaposed and even partially fused, while the carapace fontanelles had disappeared. The frontal scale was confluent with the frontoparietal. (Deraniyagala, 1930*a*, Plate XII). A larger female which came ashore to lay at Karaduva in the Gulf of Mannar on December 28th, 1930, was so different from the Bentota specimen as to justify the formation of two subspecies or races. This animal contained 138 mature eggs. Although the carapace was 860 mm. long the scutes were definitely imbricate but not as conspicuously so as in smaller and younger specimens of the hawksbill. The fontanelles were large and the frontal scale was distinct. In both, however, the egg diameters were identical as were the young which hatched out in 60 days in the first instance, in 65 days in the second. These features suggest that the differences were no more than a case of individual variation and that the disappearance of the fontanelles is closely correlated to the change of the scutes from imbrication to juxtaposition.

According to Sinhalese fishermen, Eretmochelys sheds its imbricate scutes after a certain age and develops a set of juxtaposed ones which are thin and of no commercial value. It is very doubtful if the change mentioned is a sudden one, but a comparison of the scutes of these two specimens shows that the latter part of the statement is correct.

It is also of interest to note that specimens with juxtaposed scutes are heavily parasitized by the barnacle *Stephanolepas muricata* (See Nilsson-Cantell, 1932) which so weakens the corselet by forming deep cavities that parts of the margin break off.

Diameters of turtle eggs

All four genera of marine turtles are known to breed off Ceylon, but the eggs of the common green turtle, *Chelonia mydas*, are exceedingly rare and none had been examined by the writer. As seen from the other three marine turtles the egg diameter is sufficient to identify the genus and detailed tables given by Deraniyagala (1930*a*) show that the general diameters are as follows :—

Dermochelys coriacea, 50 to 54 mm.

Eretmochelys imbricata, 35·5 to 38 mm.

Caretta caretta, 38 to 43 mm.

It was noticed in these forms that the mean between the lengths of the carapace and plastron of the newly hatched young were equal to the egg diameter as will be seen from the following table :—

	L. of C. (*1*)	*L. of P.* (*2*)	*Mean of 1 and 2*
	mm.	mm.	mm.
Dermochelys	58·5	47	52·7
	58	48	53·0
	57	47	52·0
	56	41	48·5
Eretmochelys	40	31	35·5
	40	30	35
	39	30	34·5
Caretta	47	36	41·5
	47	36	41·5
	46	37	41·5
	45	35	40·0
	44·5	35	39·7

Hence by applying this formula to three newly hatched young *Chelonia mydas* kindly obtained by Mr. H. L. Furlong from the Laccadives the egg diamter was ascertained to be 47 to 48·5 mm.

L. of C. (*1*).	*L. of P.* (*2*).	*Mean of 1 and 2.*
mm.	mm.	mm.
54	43	48·5
53	42	47·5
52	42	47

These results were confirmed when several months later Mr. Furlong sent three eggs from Minicoy which were 47·5, 48 and 48 mm. in diameter.

Variation in terrapin eggs.

Fertile eggs of Ceylon terrapins display a greater range of variation within the species than those of marine turtles. This is more pronounced in the elongate eggs of the common terrapin *Geoemyda trijuga thermalis*, than in the round ones of the soft terrapin, *Lissemys punctata granosa.*[1] There is only a single species of each genus in Ceylon, and both lay hard-shelled eggs.

Three batches of soft terrapin eggs presented by Mr. D. A. Obeyesekere from Rajagiriya, Colombo, were as follows :—

3 eggs, January 30, 1931, diameter 33 mm.

5 eggs, February, 1931, diameters from 30 to 33 mm. and weighed from 17·28 to 19·25 gms.

3 eggs, February 27, 1931, were 28·5, 29 and 30 mm.

A large female from Kalutara presented by Mr. H. Stork, June 9th, 1930, had six mature eggs in the left oviduct, five in the right. Their diameters ranged from 31 to 33 mm.

The following batches of common terrapin eggs were also examined :—

5 eggs from Colombo, November 2, 1928, were 43 to 45 mm. by 24 to 27 mm.

Three batches kindly supplied by Mudaliyar J. E. Perera from Veyangoda consisted of four eggs, January 17, 1931, were 47 to 54 mm. by 26 to 28 mm. These contained embryos.

8 eggs, January 21, 1931, were 41·5 to 46·5 mm. by 24 to 26 mm. and contained embryos. Weight of one egg 18·32 gms. of another 18·3 gms.

2 eggs, January 21, 1931, were 49 by 28 mm. and 52·5 by 27·5 mm., the former weighed 24·51 gms., the latter 25·35 gms.

Considering the numerical difference in the batches of eggs especially in Lissemys it would seem that older and larger females lay more eggs than younger and smaller ones. The great discrepancies in size and weight in the batches of Geoemyda eggs are probably also due to a similar cause. However, it is unwise to make any definite assertion until more material has been examined.

Ophiophagous habit of the cobra

Cannibalism does not appear to have been recorded in the case of the cobra *Naia tripudians* (Merrem) in a wild state, although its giant cousin *Naia bungarus* Schlegel, the hamadryad, which is not found in Ceylon is well-known for this habit. On April 8, 1932, a large living

1. This name replaces *Emyda granosa ceylonensis*, see Smith (1931)

cobra mentioned in note 9 was taken at Batadola, Veyangoda (W.P.) and sent to me by Mrs. C. H. Obeyesekere with a letter commenting on its extraordinary colour.

The specimen was unduly distended after a heavy meal and the unusual colour was due to the expansion of the white skin between the body scales. On transferring it into a cage the snake disgorged head first another cobra nearly as long as itself, and by so doing the swallower showed itself to be the dark variety termed Bereva naia by the Sinhalese who affirm that this is the most aggressive of all cobras. Examination of the victim showed numerous fang marks on the neck and throat in the area of the hood with a rent 3 cm. long in the skin of the back at mid body. The two which were both males had evidentiy fought and the conqueror had commenced its meal tail foremost instead of beginning with the head as is usual with snakes.

The total length of the swallower was 189 cm., of which its tail was 25·5 cm., while the victim was 143 cm., of which the tail was 23 cm.

The cobra is known to prey on other snakes such as the wolf snake *Ophites aulicus*, the cat snakes *Dipsadomorphus* spp. and the rat snake *Ptyas mucosus*, while the old Sinhalese tradition maintains that the cobra and tic polonga *Vipera russelli* fight whenever they meet and that the former is invariably the winner. As the tic polonga is powerful and exceedingly venomous considerable doubt existed as to the truth of this story. However, on July 1st, 1932, the cobra previously mentioned was given a living tic polonga about 80 cm. long which cowered in a corner and did not show fight even when the cobra bit it above the base of the tail. An hour later the cobra seized it by the head and after swallowing about 30 cm. of its length disgorged the polonga which struggled vigorously. On Saturday both snakes remained together, the polonga unaffected by the cobra's bites, but on Sunday morning the cobra was found heavily distended after swallowing the polonga. This meal was digested in eight days.

The polonga, however, does not always submit without a struggle and the Colombo Museum has two examples where the cobra had swallowed the polonga head first.

At 1 p.m. on March 11th, 1930, Drs. L. D. Parsons and C. O. Perera of Angoda (W.P.) saw a cobra and polonga fighting. A shot from Dr. Perera's gun killed the polonga but before he could fire again the cobra disappeared. However, it soon recovered from its fright, returned to the battle-ground and commenced to swallow its late foe. After watching this for some time Dr. Perera shot the cobra and the polonga's head protruded from the wound. The total length of the cobra was 132 cm., its tail being 21 cm., while the polonga was 108 cm., of which

the tail, was 20 cm. The other instance also shows the polonga's head protruding from the shot wound. The cobra was 129 cm. long with the tail 22 cm., while the polonga was 72 cm., of which the tail occupied 9·5 cm.

Fight between a cobra and mongoose (Plates IX and X)

On April 22nd, 1932, two weeks after capture, the cobra mentioned in the previous note, was pitted against a female mongoose, *Herpestes lanka*, which had been taken in the jungle a week earlier. As the mongoose[1] was about forty centimetres long and scarcely thicker in body than the cobra the match seemed unequal. The cobra was the first to be liberated into the wire-netted enclosure. It took up a central position, coiled itself and regarded the onlookers with raised hood, which it elevated to nearly double the previous height on seeing the mongoose. From this height of about fifty centimetres it lashed out savagely whenever the latter came within range but was too slow to land.

For fifteen minutes the mongoose, worried by its unusual surroundings, attempted to escape and completely ignored the presence of the cobra. After a short rest it resumed its exertions but suddenly uttering its short strident cry it walked up to the cobra with tail bristling. For a second they faced each other and as the snake which towered above the mongoose opened its jaws and drew back its hood to strike the mongoose darted in and sprang for the lower jaw, simultaneously gripping the cobra's body with all four legs as it bit. The snake shot up in a writhing mass of coils taking the mongoose aloft with it, then both fell to the ground where, as they struggled body to body the latter worked its jaws with a crunching action, its snout always keeping contact with the snake. Once an effective grip was obtained the mongoose was content to slacken its body and was not particular whether it was swung off its feet on to its back or constricted in the coils of the snake. Finally the mongoose twisted over on to its back in order to render its bite more damaging.

The entire struggle lasted for about five seconds after which the mongoose broke loose and resumed its attempts at escape. This may have been due to the buzz of conversation of the onlookers scaring it or it may be that the animal normally fights in short sharp bursts as is said to be its mode of combat according to those who have seen such fights in the jungle.

The cobra was crippled by the bites and could not raise itself to its former height and its lower jaw hung broken on the right side. From

1. The other Ceylon forms show a comparative disregard of snakes.

time to time the mongoose attacked the cobra which during an interval early in the fight lowered its hood and attempted to escape. This was the only attempt at flight and thereafter it remained game. In attack the mongoose invariably went for the snout, jaws or cheeks usually seizing the cobra as it gaped prior to striking. By seizing the snake in this manner it will be noticed that the jaws of the mongoose would come between those of the snake and such appeared to be the case. Early in the fight the mongoose attacked with a quick rush from the side but once it had slowed the cobra down it sprang straight in regardless of danger. The cobra's bites may not have been without effect, for often after a round the mongoose slaked its thirst at the pond within the enclosure. It is also probable that thirst was induced merely by its exertions, for once warmed up it manifested a total disregard of the cobra's bites and often remained within striking distance with its back to the foe.

A conspicuous feature was that once the cobra raised the fore part of its body, it struck with this length fully extended and was unable to shorten up. The mongoose was comparatively safe when it sprang past this striking circle into close quarters as it did time and again and when close to the snake it waited at times for as long as eight seconds until the dazed cobra opened its jaws to strike when it would spring up seize a jaw, pull the cobra down and worry it. Throughout the fight the mongoose ignored the snake's body and attacked the head, sometimes shifting its grip on to the upper part of the hood during the struggle.

The cobra was very exhausted and it missed the mongoose by wider and wider margins and gasped for breath with open jaws, the glottis protruding as a round, tubate opening. The mongoose was also very tired and it panted hard with open jaws as it ran round the enclosure seeking to escape, while the ferocity of its onslaught had abated considerably. Although it had almost run itself to a standstill time and again it would deliberately walk up to the snake, raise itself on its hind legs and fasten on to the cobra's jaw as it gaped to strike. However, it could no longer maintain its grip as it had to relax its hold to pant.

At this stage the fight was stopped after it had progressed for fifty minutes. Had it continued the cobra would have been killed. Examination of the mongoose revealed two gashes in its upper lip and it is very probable that these were fang marks. The animal was immediately placed in a concrete floored cage and showed no ill-effects whatsoever.

The cobra when seen eight hours later struck out viciously with distended hood on which were numerous tooth punctures although at no place was the skin torn. The following day it no longer hissed

Fig. 2.

Fig. 2. Cobra about to strike

Fig. 1.

Fig. 1. Mongoose close to cobra

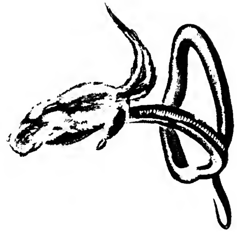

Fig. 3.

Fig 3 Mongoose leaps upon cobra

P.E.P.D. del.

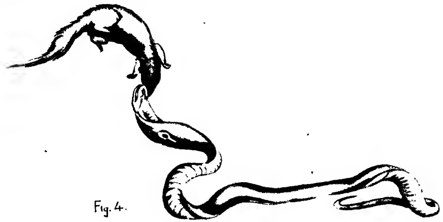

Fig. 4.

Fig. 4. Cobra recoiling with mongoose off the ground

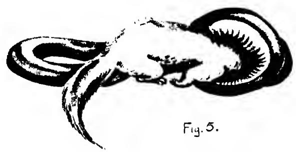

Fig. 5.

Fig 5. Cobra on ground, constricting

Fig. 6.

P.E.P.D. del.

Fig. 6. Cobra and mongoose twisting on ground

or distended its hood but lay in a feverish stupor, but a guinea pig placed in the cage was struck by it and died in ten minutes. A day later it swallowed a frog in spite of its fractured jaw and recovered from its ordeal in two weeks. This article is illustrated by camera lucida drawings of photographs of the fight kindly lent me by Mr. A. R. Hughes.

In conclusion the following are the features of the fight :--

(1) The mongoose never attacked the snake's body.

(2) The mongoose sprang inside the cobra's striking circle and awaited its attack at close quarters.

(3) Once warmed up the mongoose did not avoid the cobra's bites as it sprang in.

(4) The mongoose fought in rounds lasting about five seconds each.

(5) After most of the rounds the mongoose drank water.

(6) Once the fight commenced the cobra never once protruded its tongue which was deeply retracted

(7) Once on the ground, both animals rolled over and over, the cobra at times constricting the mongoose which turned over on to its back.

(8) The striking radius of the cobra depends on the length of body it erects, and the mongoose when within this radius was comparatively safe.

(9) The cobra was comparatively slow in striking.

(10) There were no rents in the skin of the cobra although there were numerous punctures.

P. E. P. Deraniyagala.

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4. A Stranded Blue Whale

(Plate XI)

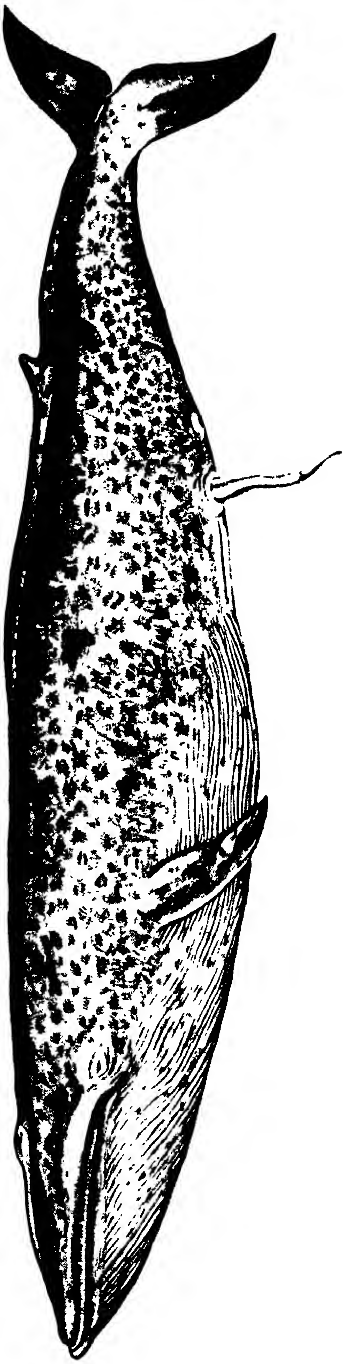
Although both sperm and baleen whales have been stranded on the Ceylon coast from time to time no specimen had hitherto been

available for examination before putrefaction set in. On May 26, 1932, at 2 p.m. a male blue whale *Balaenoptera musculus* (Linné) ran aground in Koddiyar Bay, Trincomalee, near the mouth of the Tamblegam lagoon. Although sightseers had cut off the dorsal fin and had wounded the animal with knives and bullets it lived until the night of June 12th. It was examined by me on June 6th after it had suffered this mutilation and was found in about 4 feet of water although it actually lay in a deeper cavity which it had excavated in its struggles. Hence only the dorsal parts were visible and it was only after the animal had died that a detailed examination was possible.

Observations were made from a canoe from a distance of about six yards from the captive which " spouted " about twice to the minute and at times partially lifted its " flukes " to which numerous sucker fishes were attached. These were very noticeable in the water after the death of the animal and bit me whenever I dived to measure the carcass on June 13th, while on the following day they swarmed under the bloated carcass and had evidently come from all parts attracted by the smell.

The life colours of the whale were a pinkish grey suffused with a blue tinge and there were numerous irregular dark blotches which were smaller and further apart on the body than on the tail. Each blotch was connected to the others by fine anastomosing black lines. The " flukes " were a uniform black dorsally. The bloated dead specimen showed that the ventral colouration was lighter but similar to the dorsal which was much darker than during life. The under side of the flippers were a very light grey. The whalebone plates and baleen bristles were entirely black and the double row of hairs on the chin were of a light amber colour.

The dorsal fin was located rather behind the level of the anus but was so mutilated that it can only be described as relatively small in size. The blow hole was not in a conspicuously raised prominence. It consisted of three slits which converged anteriorly and continued a short way as a single slit. On either side of the blow hole was a thick, low ridge which coalescing with its fellow ran some way down the middle of the snout anteriorly to form a distinct carina. Viewed dorsally the snout was elliptical in outline. A dorsal ridge commenced on the posterior half of the back in front of the dorsal fin and was most pronounced on the tail. A noticeable feature was the presence of numerous dermal bumps, each about three inches long, on the sides of the whale and were most conspicuous about the middle of the animal's



Male Blue Whale. *Balaenoptera musculus* (Linné)

length. Some workers have found that such bumps on the whale *Balaenoptera borealis* are caused by parasitic copepods of the genus Penella, and it is possible that these may be due to a similar cause although externally there was no evidence of such parasites. Each bump was grey flecked with black and with a black pattern resembling the fern-like arrangement of frost crystals on a window pane. This black pattern branched off from a definite longitudinal median axis and the whole was bounded by larger blotches of black pigment. The flipper was slightly falcate and of moderate size, and consisted of four digits. The caudal lobes or " flukes " had regular edges and the usual caudal notch lay between them.

The right upper jaw of the animal showed that all the baleen plates and their bristles were a uniform black smeared with a greenish blue film which could be wiped off. The plates were triangular and twisted and there were 230 on the right jaw.

The right half of the animal which was above water exhibited the longitudinal ventral ridges which extended from the throat to the umbilical groove. Estimating from the number exposed, the total number of belly ridges was probably 48 or 50. There were 27 gular ridges also visible which ended at the right mandible between the symphysis and angle of gape.

The whale died on the night of the 12th June and by 2 p.m. June 13th the tail alone emanated a faint putrefactive odour with an incipient sloughing of the outer cuticle.

When seen on June 13th at 6.30 a.m. the carcass was heavily distended and the intestinal gases had blown the stomach out of the mouth as a large balloon marked with yellow, dull red and brown concentric patterns of muscle fibres. Consequent on this bloating the carcass had tilted over on to its left side and the right half was exposed revealing the ventral ridges and penis which was fully extended. This was 6 feet 3½ inches long and at the posterior end of the umbilical groove. At its base was a circular fleshy ridge and after the proximal two-thirds of its length there was a faint dermal fold. The termination possessed a loose spongy structure resembling a putrid lung, and as it is not known whether this was due to putrefactive sloughing or whether it was a normal part of the penis it is omitted from the illustration. The umbilical groove showed a larger and a smaller protuberance anteriorly and ended posteriorly at the penis.

The dimensions of the whale in feet and inches and cm. are as follows :—

Total length (curved measurements)	59′ 10″ (= 1802 cm.)
Length of blow hole	2′ 1″ (= 62 ,,)
Posterior width of blow hole	1′ 0″ (= 30 ,,)
Tip of snout to blow hole	9′ 11″ (= 298 ,,)
Tip of snout to eye	13′ 6″ (= 406 ,,)
Length of eye	6″ (= 15 ,,)
Eye to ear	3′ 6″ (= 105 ,,)
Width of rostrum across front of blow hole	7′ 7″ (= 228 ,,)
Eye to eye, over blow hole	9′ 9½″ (= 294 ,,)
Length of rostral carina	8′ 6″ (= 256 ,,)
Eye to axilla	9′ 3″ (= 278 ,,)
Blow hole to dorsal fin	36′ 4½″ (= 1105 ,,)
Base of dorsal fin	1′ 0″ (= 30 ,,)
Dorsal fin to caudal notch	12′ 7½″ (= 380 ,,)
Length of a caudal fluke to notch	7′ 7″ (= 228 ,,)
Length of flipper	6′ 5″ (= 193 ,,)
Width of flipper	2′ 3½″ (= 69 ,,)
Length of extended penis	6′ 3½″ (= 189 ,,)
Length of umbilical groove	3′ 11½″ (= 119 ,,)
Penis to base of flukes	15′ 11″ (= 479 ,,)
Anus to base of flukes	12′ 5″ (= 373 ,,)

P. E. P. DERANIYAGALA.

PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY, 1931 Session

Nineteenth Annual General Meeting

Minutes of the Nineteenth Annual General Meeting of the Ceylon Natural History Society held on February 10th, 1931, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The retiring President, Dr. A. Nell, took the chair and there were 15 members and 7 visitors present.

In view of the business to be conducted the minutes of the previous meeting were taken as read and confirmed.

The following were elected ordinary members of the Society :—

Messrs. P. Kirtisinghe, B.Sc., M. Crawford.

The following were elected Student-Members of the Society :—

Messrs. B. A. Baptist, S. E. Dias, V. S. V. Fernand, M. Fernando, A. L. John-pulle, R. Kirtisinghe, P. E. H. Koelmeyer, A. R. Perumal, R. A. de Rosayro, B. de Silva, K. B. Sangakkara, C. L. de Zylva, L. J. D. Fernando.

The Report of the Hony. Secretary, and the Balance Sheet of the Hony. Treasurer, which were in the hands of the members were taken as read and adopted.

The President, on behalf of himself and the other office-bearers, retired, and proposed that Dr. Pearson occupy the chair.

Dr. Pearson proposed that Sir Graeme Thomson, the Governor-elect, be asked to be Patron of the Society, which proposal was unanimously approved.

Dr. Pearson proposed that the Vice-Presidents of the Society be the Hon. Mr. Bourdillon, C.M.G., and Sir Solomon Dias Bandaranaike, K.C.M.G. and they were unanimously elected.

Professor Ball was elected President, proposed by Dr. Pearson and seconded by Mr. Henry. Professor Ball then took the chair.

The following Vice-Presidents—proposed by Professor Ball and seconded by Mr. Burt, were elected :—

Dr. A. Nell, M.R.C.S. ; Dr. J. Pearson, D.Sc., F.L.S., F.R.S.E. ; Hon. Mr. W. E. Wait, M.A., M.B.O.U., C.M.G. ; C. T. Symons, Esq., B.A., F.I.C., F.R.G.S. ; The Very Rev. Fr. Le Goc, B.Sc., Ph.D., O.M.I.

Mr. D. R. R. Burt, B.Sc., F.L.S., F.R.S.E., proposed by Dr. Pearson and seconded by Dr. Nell was re-elected Hony. Secretary.

Mr. A. H. Malpas, proposed by Professor Ball and seconded by Mr. Burt, was re-elected Hony. Treasurer.

The members of the Council :—W. W. A. Phillips, Esq., F.L.S., M.B.O.U. ; Dr. S. E. Fernando ; Messrs. E. C. T. Holsinger ; G. M. Henry ; Professor F. O'B. Ellison, M.D., B.Ch., B.A.U., B.A. ; and Mr. D. C. Gunawardana—proposed by Professor Ball and seconded by Mr. Burt, were elected.

The student-member of Council M. Fernando, Esq., proposed by Mr. P. E. H. Koelmeyer and seconded by Mr. R. Kirtisinghe, was elected.

Dr. Ball then called on Dr. Nell to give his paper on " Some Ceylon Medicinal Plants."

Dr. Nell said that a considerable number of plants were useful medicinally and many deserved more extended observations than he has been able to give. Some have the credit of a good repute from antiquity being mentioned in ancient Sanskrit works, in the writings of the early Arabian physicians, and by Garcia de Orta in Goa in 1653. The lecturer said he would confine his remarks to those plants which he knew of, both directly and from the testimony of users, and he would treat the plants under their Natural Orders and classify them according to their medicinal uses.

Of the Acanthaceae *Justicia betonica* is used as a poultice for boils, while *Adhatoda vasica* (Sihn., Wanepala or Adhatota) a well-known boundary plant of paddy fields is used as an insecticide. Decoctions of this plant were used for the treatment of Chronic Catarrhs of the throat or the chest and to allay cough. This plant is in use in hospitals of South India. *Hydrophila spinosa* (Sinh., Katu-ikiri) common everywhere in abandoned paddy fields is a powerful diuretic. The leaves either dried or fresh, made into a decoction caused rapid diminution of dropsical swellings. Prolonged therapeutic tests over forty years by the Medical Officer at Balangoda, the late Dr. Jayasinghe, gained him a medal for his research, and caused the introduction of this plant into the Supplement of the British Pharmacopeia.

Acorus calamus (Sinh., Wadakaha) one of the Aroidae is used as a decoction for colic, and the aromatic oil of the leaves is used in medicinal oils.

Of the Asclepiadeae, *Tylophora asthmatica* (Sinh., Bin-Nuga), is used for the same purpose as Ipecacuanha; decoctions of *Oxystelma esculentum* (Sinhalese and Tamil, Kulappalai) are used in cases of hydrophobia; while *Hemidesmus indicus* (Sinh, Irumusu) the Indian Sarsaparilla has a place in the Indian and British Pharmocopeias as a demulcent. The fresh leaves and tender stems are chopped up and cooked with rice. *Calotropis gigantea* (Sinh., Wara) has many uses; the plant itself is said to keep cobras away; the fresh leaves are used as poultices to swellings: the powdered oot or a liquid extract of it is given to malarial cases, while the latex is used for leprosy. It is said that the addition of *wara* root to ganja makes the smoker aggressive.

Combretaceae. One plant of this order *Terminalia chebula* (Sinh., Aralu) has also many uses: the unripe nuts are used as a laxative: the ripe nuts, rich in tannin, are used as astringents, while a poultice of the bark is used for dry eczemas. The oil expressed from the ripe nuts is an ingredient in many medicinal oils. Of the Compositae *Ageratum conyzoides* (Sinh., Hulantala) and *Emilia sonchifolia* (Sinh., Kadupara), the leaves are used as dressings for cuts and sores. *Vernonia anthelmintica* (Sinh., Sonni-Noyan) is used as a sedative and febrifuge, while *Gynura pseudo-china* (Sinh., Ala-bēth) supplies another palliative for leprosy, the tubers being cooked and eaten. An infusion of the leaves of *Spilanthes acmella* (Sinh., Akmella) is used externally for sore throat.

Convolvulaceae. The best known is *Operculina* or (*Ipomóea*) *turpethun* (Sinh., Trasta-vela) the false jalap, which is almost as good as the true jalap. Other two members:—*Evolvulus alsinoides* (Sinh., Vishnu-Kranty) is used as a febrifuge, and *Ipomœa bona-nox* is used for sprue when the tender fleshy calyces are made into a palatable vegetable curry.

Eurphorbiaceae. Three plants are well-known medicinally; *Acalypha indica* (Kuppameniya) as a vermifuge, *Phyllanthus emblica* (Nelli) as a laxative and febrifuge and *Euphorbia nuta* (Dadakeriya) a spurgewort is a useful vermifuge for children. Of the Labiatae, *Coleus aromaticus* as a decoction of the leaves, is used for asthma, *Plectranthus zeylanicus* (Iriveriya) is a carminative, while *Ocimum sanctum* (Madurutala) the sacred Basic of India keeps off mosquitoes, and an infusion of the leaves is used for coughs and catarrh. In India this latter plant is found at every shrine to Vishnu.

Azadirachta indica (Kohomba) one of the Meliaceae has many uses: the fruit is laxative, the fruit and leaves vermifugal, the oil from the seed is antiseptic and the bark powdered and made into a decoction is an effective febrifuge.

Rubiaceae. *Ixora coccinea* is often stolen from gardens to be made into a decoction for sore eyes, while the weed *Hedyotis auricularia* is used for dysentery and colitis.

Rutaceae. *Limonia alata* is used as a fomentation for muscular pains.

Feronia elephantum, the wood apple, is astringent when unripe, and the ripe fruit is used in cases of kidney trouble. *Aegle marmelos* (Beli or Bael) is mentioned by early Sanskrit writers, by the Arabian physicians, and by Garcia de Orta. The ripe fruit is tonic and laxative and eaten uncooked; the unripe fruit is cooked, and the pulp strained and sweetened and used in cases of acute dysentery. The plant is much used at the present time and may be stored as marmalade. The roots are one of the ten in the much vaunted *dasamula*.

Of the Scrophulariaceae, *Herpestis monnieria* (Lunuvila) supplies a laxative, and an infusion of the leaves of *Centranthera procumbens* (Dutu salutu) is used as an eye-wash. A decoction is used internally for malaria.

Solanaceae. *Solanum indicum* (Tibbatu) the wild brinjal is eaten in curries for Bronchitis. *Withanthera somnifera* has the same properties but is narcotic. *Datura fastuosa* has been known for centuries as a cure for asthma, the dried leaves being smoked; but in excess this plant is poisonous and causes delirium—added to arrack the drinker goes mad.

If we try to picture the details of human life in jungles we can understand the uses of the plants. Freshly cut segments of stems and roots are used to brush the teeth; bruises, cuts, and wounds are treated with leaves, sores caused by leach bites are treated with poultices of leaves and for fevers febrifuges are discovered.

In the discussion that followed Professor Ball spoke of the debt that Western medicine owed to the East and Dr. Ellison discussed the uses of water hyacinth.

Dr. Pearson proposed a vote of thanks to Dr. Nell for his lecture and expressed the thanks of the Society for his services as President and for the keen interest he had taken in the Society although he had to travel from Kandy for every meeting. This was seconded by Mr. Burt and passed with acclamation.

Professor Ball called on Mr. Burt to exhibit a live specimen of *Manis crassicaudata*, the Ceylon ant-eater, which had been caught by Mr. L. Burgess of the Irrigation Department at Uggaldeltota, twelve miles east of Balangoda.

The meeting then terminated.

Ninety-eighth General Meeting

Minutes of the Ninety-eighth General Meeting of the Society held on March 10th, 1931, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President of the Society, Professor N. G. Ball, took the chair, and there were present 43 members and 6 visitors.

The minutes of the previous meeting were read and confirmed.

The following were elected Student-Members of the Society :—

Miss R. M. Beven and Miss L. G. Selliah.

The President introduced the lecturer, Professor W. C. Osman Hill, as a Comparative Anatomist who had made a close study of the Primates and called on him to give his lecture on " The Apes' Place in Nature."

Dr. Hill explained that his title was of the nature of a problem to which answers had been given, but to which the old answers, in the light of new knowledge and conceptions, would not now satisfy the facts.

Huxley's doctrine that the Apes resemble mankind more than the other Primates holds good, but John Ray's definition in 1693 may not be regarded as scientific, as the negative character of the absence of a tail is not important and does not hold good in all cases. An Ape may now be defined as a large Primate which tends to adopt an erect or semi-erect attitude habitually.

There are four distinct types of Apes, the Gibbons, the Orang-utans, the Gorillas and the Chimpanzees.

Of the twelve kinds of Gibbons, all are small and found in the Oriental Region. They are mostly black with a varying amount of white hair round their small flat faces, while the nostrils are small. Their salient character is the possession of enormously long arms, which, when the animal stands erect, reach to the ground. The long arms are associated with a brachiating mode of progression in a perfected arboreal type of existence. On the ground the Gibbon walks more erect than does any other ape and holds his long arms above his head or behind his back to keep them out of his way and to aid in balancing. A curious habit of the Gibbons is the holding of vocal concerts at sunrise and sunset, and with this is associated the possession of large pharyngeal air-sacs. The most primitive of the giant apes is the Orang-utan, a large sluggish ape with long arms and very short legs. They

are least modified for terrestial locomotion, which on account of the inverted feet, is difficult. They are covered with red hair, while the face is slate coloured. The jaw is prominent giving that appearance known as Semognathism. The cranium is high, the eyes and ears are small, the lips are mobile and there are laryngeal air-sacs present, much larger relatively than in the Gibbons. It is to be noted that the feet of the human baby are inverted like those of the Orang-utan.

The Gorillas, the largest apes, are most like man in their posture and mode of progression. They were first known to science in 1860 through Paul B. du Chaillu. Gorillas walk on the whole flat surface of the sole of the foot which shows the beginnings of a heel. The legs are short and the arms long, but not so long as in the Orangs or Gibbons. The face is bestial, especially in the adult male where the large canines, prominent square cut jaws, large nostrils, well padded alae and prominent brow-ridges are conspicuous. They are restricted to tropical West Africa where separate lowland and highland races are found.

The Chimpanzees are smaller and more intelligent. They have large ears, smaller brow-ridges and a less muscular development than the Gorillas. Their lips are extremely mobile. The arms are longer than those of the Gorilla but the thumb is better developed. They walk in a semi-erect attitude with the fingers and toes tucked under the hands and feet. There are many races, all restricted to tropical Africa. Intermediate forms between Gorillas and Chimpanzee are known, and they have been explained as crosses between these two African apes. Most of them are probably Gorilla-like races of Chimpanzees, generally of the kind recorded by du Chaillu as Koolokamba. This opinion is corroborated by Sir Arthur Keith.

The lecturer then discussed some of the fossil forms related to the apes, exhibiting slides of *Dryopithecus* jaw, a fossil ape of Europe allied in many respects to the Chimpanzee, and *Australopithecus*, the South African Ape Man. In the slide of the braincast the fissures were recognisable. The specimen was a " child " of about six years old, for it had its milk teeth. The brain shows a great expansion of the parietal association area, an area which serves to associate receptions from auditory and visual sources. Gabriel Max's famous painting of Pithecanthropus was then shown ; it was painted from data given by E. Haeckel before the actual specimen was discovered.

In discussing the relatives of the apes apart from mankind Dr. Hill discussed *Tarsius*, the lowest living form that exhibits the glimmerings of the structures that have raised the Apes and Man so much above their fellows ; fossil Eocene Tarsioids ; and the various stages in the evolution of the higher Anthropoids. The Squirrel Monkey was especially mentioned as having a brain relatively larger than the human brain, and the Snub-nosed Monkey was shown to indicate that the possession of an external nose was not necessarily a human attribute.

In conclusion Dr. Hill said that the apes stood intermediate between man and the lower Primates and were if anything, more nearly related to man than to monkeys. They have obviously progressed a good way, in the same direction that man himself so successfully took, but they have failed to reach so far. They have never completely forsaken the trees and there they remain. They cannot themselves be regarded as ancestors of man, but are probably our brothers who have not been so successful as ourselves in the game of life. In the discussion following the lecture Professor O'Brien Ellison expressed his extreme interest in the subject matter, and stated that he was glad to learn the answer to a problem that he had had for a long time—the origin of the bag-pipes from laryngeal-sacs of the apes. Dr. Hill replied that this was probably true in the case of the Irish bag-pipes. Mr. Bantock inquired where the Koolokamba were found, and was informed that they existed in West Africa. Dr. Pearson while complimenting the lecturer and expressing the wish that the Society should hear more on the subject perhaps in a lecture on " The Missing Link " took exception to Dr. Hill's opinion regarding the creation of new species, and said that when a certain group of characters were found to be constant in certain local races it was only right that they should be labelled by a new specific or sub-specific name.

The Chairman then expressed the thanks of the Society to Dr. Hill and called for a hearty vote of thanks which was carried with acclamation.

The meeting then terminated.

Ninety-ninth General Meeting

Minutes of the Ninety-ninth General Meeting of the Ceylon Natural History Society held on June 9th, 1931, in the Reading Room of the Colombo Museum Library.

The President of the Society, Professor N. G. Ball, took the chair, and there were present 8 members and 13 visitors.

The minutes of the previous meeting were read and confirmed.

The following were elected ordinary members of the Society :—

Rev. R. S. de Saram and Miss M. Linwood, Messrs. L. G. O. Woodhousé, E. B. Wickremanayake, D. L. F. Pedris, and J. V. Collins.

The following was elected a student-member :—

Mr. F. A. Pinto.

The Chairman then called on Mr. G. M. Henry to give his lecture on "The Praying Mantis."

Mr. Henry said that he had been asked whether the name "praying" should not be spelt "preying" but was obliged to give a reply in the negative, for the term refers not to the predacious nature of the creature but to its customary attitude of sanctimonious piety with arms either folded devoutly or extended as if in invocation of the Deity. In some countries mantises are objects of superstitious veneration on this account.

The lecturer discussed the Insects in general, the largest group of air breathing animals, and placed the mantis in the order *Orthoptera,* a group characterised by the possession of mouth parts of the biting type and by the possession of wings which fold in radiating lines like a fan. The *Orthoptera* are rather primitive insects of a generalised type. They afford the best examples known of two phenomena of common occurrence among insects. The production of sound, and modifications of colour and form for purposes of concealment. Mantises are not very notable in respect of the first of these but give place to no other family in respect of the second. Metallic colouring is rare among the *Orthoptera* and all the Ceylon mantises are soberly coloured in plain greens, browns and greys.

Mr. Henry then dealt with the structure of the Mantis, its head with large eyes, antennae often in constant vibration, its biting jaws and mobile neck: its long prothorax and remarkably developed fore-legs with femoral and tibial armature, its ill-consolidated meso- and meta-thorax, each of these segments with a pair of wings. Although in essentials all mantises conform to one general type, they show all sorts of extravagant developments as in the tag-like expansions on the legs of some and on the sides of the thorax in others.

In the life history of the mantis there are many peculiarities. One of these is seen in the laying of the eggs. The mother takes up her position on the bark of a tree or wherever she lives normally and deposits a secretion of mucous produced by her colleterial glands. When a layer or two has been deposited a layer of eggs, one or two side by side is laid in the middle, then another layer of mucous. and more eggs and so on until perhaps 50 or 60 eggs have been laid and completely covered and concealed by the mucous which soon hardens in the air and protects the eggs from all ordinary enemies. Some enemies, however, can penetrate this armour and there are wasps which pierce the hard egg-masses of Mantises with their ovipositors and deposit their eggs beside those of the Mantises so that the Mantis eggs become food for the young wasp larvae when they hatch out.

Normally, however, the young mantises hatch out and emerge through slits in the hardened mass of mucous, to hang by a silken thread from their nursery, each baby mantis enclosed in a delicate membrane. This membrane soon ruptures and the young escape, each thereafter to make its own way in the world. They are rapacious from the start and if kept in a cage become reduced in number by cannibalism, but in nature this fate is averted by their tendency to scatter as widely as possible immediately after hatching.

Throughout their lives Mantises showed two conflicting emotions, firstly they would like to eat, and secondly they would like not to be eaten. They are incredibly ferocious towards any creature they feel able to overpower, and against an enemy they will assume a menacing manner trying to make themselves out bigger and more dangerous than they really are. In general Mantises prefer to be left alone, and show a fine spirit of sportsmanship in killing nothing which they do not actually require for food.

The Ceylon Mantises could be grouped into three classes :—(1) Grass and twig mimics, (2) Leaf and flower mimics, and (3) Bark and moss mimics. Mr. Henry showed slides of these mantises and notable among the insects shown were :—

(1) *Deiphobe infuscata* and *Oxyopthalmus gracilis.*

(2) *Hierodula taprobanae, Gongylus gongylodes.*

(3) *Humbertiella affinis, Muscimantis montanus.*

The Mantises form a small family as Insect families go, for the most recent list gives but 1,834 species, while in a single family of beetles, say the Rhyncophora or Weevils there are over 30,000 species known and the number is increasing.

In conclusion Mr. Henry stated that he was glad that the Mantis was of no immediate use to man, but that like the great bulk of insects it helped to maintain the balance of nature by preying on other insects.

Several questions were asked the lecturer who replied and Dr. Hill then proposed a vote of thanks complimenting the lecturer on the exceptionally interesting lecture to which the Society had listened and deprecating the commercial attitude towards science, on which point he thoroughly agreed with the lecturer.

The vote of thanks was carried with acclamation and the meeting then terminated.

One Hundredth General Meeting

Minutes of the One Hundredth General Meeting of the Ceylon Natural History Society held on July 28th, 1931, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President of the Society, Professor N. G. Ball, took the chair and there were present 14 members and 6 visitors.

The minutes of the previous meeting were read and confirmed.

The following were elected ordinary members of the Society :—

Messrs. D. E. V. Koch, B.Sc. ; C. P. Abeyesinghe ; and W. D. Hewavitarne.

The following were elected student-members of the Society :—

Messrs. C. I. de Silva, E. F. Modder, A. S. Outschoorn, R. W. P. de Soysa, L. A. Gunawardene, G. A. K. Rockwood, A. E. C. Perera, C. E. V. P. Amerasinghe, R. Jeremiah, A. R. Majid, W. S. R. Mendis, T. V. N. Perera, C. S. Ratnavale, A. M. D. Richards, K. Satchithananda, M. M. M. Sheriff, H. C. H. Soysa, S. Suppiah, and V. Thillainadarajah.

The President read an invitation from the Honorary Secretaries of the Royal Asiatic Society (Ceylon Branch) to the lecture by Mr. A. R. Hughes, B.A.O.U., on "Hawks, Eagles and Birds of Prey" to be held on 4th August, 1931, at 6.30 p.m. in the Reading Room of the Colombo Museum Library.

The President intimated that there would be no General Meeting of the Society in August.

The President then called on Mr. D. C. Gunawardena to give his paper on the "Mangrove Plants of Ceylon."

Mr. Gunawardena said that the plants collectively called mangroves are confined more or less to the tidal limits of brackish waters of creeks and lagoons of tropical shores. They often grow so luxuriously as to form a forest on the sea through which the rays of the sun scarcely penetrate; as a consequence of this there is little undergrowth. The tangled nature of the roots which stand up in the air through the soft yielding mud makes it difficult to penetrate the mangrove forests.

The plant communities of the tropics may be classified as :—

(*a*) Closed forests—such as are found in the hill country where the tree tops are crowded together. In these, grass is absent but lianas, orchids, ferns, mosses and lichens abound. (*b*) Park-land—familiar to hunters in Ceylon, is free from climbing plants, and trees are scattered. (*c*) Grass-land—where trees and shrubs are absent. Park land is a transition stage between (*a*) and (*b*). (*d*) Maritime swamp and aquatic vegetation. Here the flora is often floating, submerged, amphibious or subjected to periodic inundations. If the foundation is salt or brackish we get the strand vegetation of the seashore, but if the area is subjected to tidal effects, the mangrove vegetation is evident.

Mangroves are an arboreal group found in brackish water, in river deltas and along river banks as far as the tidal limits. The distribution is confined to the tropics,—West Indies and the Amazon, Nigeria, Tanganyika Territory, the Ganges, Malay Archipelago, the swamps of the Philippines and the North coast of Australia.

In the mangrove swamp the water is full of mud and decaying vegetation: the dead leaves and rotting branches give a characteristic smell and the mud is a horrible black slime. As the roots of these plants cannot get a firm grip in the mud and as the absence of air in the soil affects the plant adversely, the plant has to contend with the problems of absorption of water, and respiration. Also the seeds are in danger of being washed away.

The mangroves are adapted to meet these adverse conditions.

There are 26 species of mangroves distributed among nine families and of these only one, *Acanthus* is a herb, the rest are trees and shrubs.

Rhizophora is the most widespread and well-known. There are two species of it in Ceylon.

Bruguiera is also represented by two species. These two form the bulk of the Mangrove forests of the coast, the former is more common on the East and the latter on the South. Both these plants have many features in common but *Rhizophora* has 4 sepals and petals, while *Bruguiera* has 8-14.

Rhizophora, the Mangrove *par excellence* is a tree with spreading branches and dark green leaves. It supports itself in the mud by sending out aerial roots which act like buttresses to protect the plant against the wind. The roots have another function, they are spongy and air diffuses to the soft tissue through the lenticels to get to the roots below the mud. The roots in the mud have spongy tissue more extensively developed. The spongy tissue acts as a reservoir for the air taken in from above. The leaves are shiny and reflect excess light. The young leaves are well protected from drying by stipules and mucilage, excreted from the glands at their bases, which envelopes the whole bud. The flower of Rhizophora is not abnormal but the germination of the seed has many peculiarities.

The mature fruit does not fall to the ground on germination but remains on the plant, a condition known as vivipary. The stages of growth are as follows :—

Only one of the two ovules develops, and the embryo consists of one cotyledon and there is no true radicle as in the case of other plants. The full grown cotyledon consists of an upper part likened to a Phrygean cap by Fr. Le Goc while the lower part is hollow and elongated. Fitted to the base of the hollow tube is the hypocotyl which bears a small bud on the upper end.

During germination the cotyledon feeds the hypocotyl with food absorbed from the endosperm, meanwhile the cotyledon forces its way out of the fruit through the micropyle and continues to elongate, reaching a foot or two in length. The total period for full germination is nine months.

The hypocotyl is green in colour and swollen at the base. Hypocotyls hang in the air like candles in a grocer's shop. When the fruit drops the hypocotyl sticks in the mud and adventitious roots arise from its base and the bud begins to sprout forth.

The Mangrove is one of Nature's most important geographical agents in colonizing and reclaiming mud. The leaves of the Mangrove as well as floating rubbish accumulate about the roots. This raises the level of the ground. Eventually the soil becomes hardened and raised and the Mangroves then tend to die while the ordinary jungle trees encroach on it. In this way the continual development of Mangroves reclaims enormous stretches of land.

Bruguiera is a smaller plant having a very specialized type of air-breathing root called a pneumatophore. Some roots rise above the mud and bend down again into the water, the exposed part looking like a bended knee. These are called knee roots. In the exposed parts are the lenticels through which air enters. The submerged part of the knee root is spongy with an abundance of air spaces.

Fertilization is self-effected. The stamens are enclosed within a leaf-like envelope that forms an appendage to the base of the petals. When the flower expands the blades from the leaf-like envelope open suddenly releasing the enclosed stamens which spring forward to the centre of the flower scattering the pollen-grains on the stigma.

Ceriops is the third genus. It is found at the estuary of the Mahaweliganga.

Kandelia is doubtfully present in Ceylon.

Sonneratia is common in the west and south. It is easily identified by clusters of erect pneumatophores which grow all round it.

Acanthus ilicifolius is a perennial herb, with spiny hollow leaves. It is found as an undergrowth to the other Mangroves and is dominant at Batticaloa.

Avicennia officinalis is called in English the White Mangrove. It has no stilt roots but sends up erect pneumatophores from its cable like roots.

Carapa, Lumnitzera, Scyphiphora and *Aegiceras* are other Mangroves.

The Nipa palm (*Nipa fruticans*) is common on the south west coast. It grows in the water and may be called a semi-mangrove. One other semi-mangrove common in Ceylon is a fern *Acrostichum aureum.*

The lecturer then concluded by discussing the economic possibilities of the Mangrove. It is well-known that Mangroves abound in tanning material. Previously "cutch" obtained from the heart-wood of *Acacia* was used but the supply from India and Burma was not reliable. Now tannin from the mangrove has replaced it and there are factories in East Africa, the Philippines and Borneo. Mangrove wood is highly prized as firewood. The Nipa palm is an important source of Alcohol and Vinegar.

In Australia the oysters flourish at the roots of the Mangrove which plants are on this account extensively cultivated.

The lecturer pointed out that the possibilities of the Ceylon Mangroves required a fuller investigation.

In the discussion which followed this Miss Linwood and Mr. Burt made a few comments and asked questions to which Mr. Gunawardena replied.

The meeting then terminated by the Chairman proposing a hearty vote of thanks to the lecturer. This was carried with acclamation.

One Hundred and First General Meeting

Minutes of the One Hundred and First General Meeting of the Ceylon Natural History Society held at 5.30 p.m. on September 8th, 1931, in the Reading Room of the Colombo Museum Library.

Professor N. G. Ball occupied the chair and there were at least 9 members and 4 visitors present.

Mr. F. N. Betts and Miss G. F. Opie were elected ordinary members and Mr. J. L. C. Fernando a student-member of the Society.

The Chairman then called on Dr. S. E. Fernando to deliver his lecture on "Protozoan Parasites of Man."

Dr. Fernando said that protozoa and man belonged to the first and last phyla in the evolutionary series of the animal kingdom and that parasitism is one of the many types of association that may exist between different species of living organisms. It is an association where the parasite is benefited, obtaining food and protection with the least possible effort, but is detrimental and sometimes disastrous to the host.

The conception of parasitism implies antagonistic relationship between two correlated beings, parasite and host the one attacking, the other defending. Again some parasites are in turn attacked by other parasites :—

> "Big fleas have little fleas
> Upon their backs to bite 'em,
> And little fleas have lesser fleas
> — and so *ad infinitum.*"

Then he distinguished parasitism from two other animal associations, viz., symbiosis and commensalism. In view of the different modes of life he divided protozoa into two groups, epizoic and entozoic.

The anatomy and the life history of protozoa were dealt with in detail followed by a classification into four classes according to the presence or absence and nature of locomotor organs.

(1) *Sarcodina,* (2) *Mastigophora,* (3) *Sporozoa,* (4) *Ciliata.* He gave the chief characteristics of each of those four groups. For descriptive purposes he divided protozoan parasites into (*a*) Intestinal protozoa, (2) Blood inhabiting protozoa.

In the *Sarcodina* he dealt with the different *Amoebae* with special reference to *Entamoeba histolytica* the cause of amoebic dysentery.

In the class *Mastigophora* he dealt with *Trypanosoma, Leishmania tropica* and *L. infantum.*

In the *Sporozoa* he dealt with the malarial parasites.

In the *Ciliata* he mentioned the less common *Balantidium coli.*

Lastly he described the controversial group of Spirochaetes with special reference to organisms of syphilis, parangi and rat-bite fever.

He stated that host-parasite specificity is a problem of great interest to the Zoologist especially from the evolutionary point of view.

The lecture was fully illustrated with diagrams with maps showing incidence of disease caused by the parasites and with lantern slides. These were shewn through the recently purchased epidiascope.

At the close of the lecture comments were offered by Dr. F. Hirst.

The meeting terminated with a hearty vote of thanks to Dr. Fernando.

One Hundred and Second General Meeting

Minutes of the One Hundred and Second General Meeting of the Ceylon Natural History Society held on 13th October, 1931, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President, Professor N. G. Ball, took the chair and there were 19 members and 1 visitor present.

The Secretary proposed that in reading the minutes the summary of the previous lecture be taken as read. This was seconded by Mr. G. M. Henry and passed unanimously. The minutes were then read and confirmed. The President called on the Very Rev. Fr. Le Goc to give his lecture on " Stimulus and Response."

The lecturer discussed the principle of stimulus and response in the animal senses and therefore in human senses. There were six primary senses, including heat perception which did not enter into the present discussion, the six senses being touch, taste, smell, hearing, sight and heat perception.

In the case of non-living organisms stimulus and response is just action and reaction which can be represented by the equation $m_1 v_1 = m_2 v_2$, but in dealing with the living body the response or reaction to the stimulus may be out of all proportion to the stimulus used.

The nature of the response depends on the nature of the organ of perception, as in a plant where the response to light is a turning towards the light by the stem, and away from it by the root. In this case the direction and nature of the response are beneficial to the organism. In a similar way the reaction to gravity, geotropism, is beneficial to the organism.

The lecturer then discussed chemical stimuli in plants such as the sun-dew and the stimulus of humidity and of light.

Among animals the lowest forms, as Amoebae, are like plants but in higher forms the senses are specialised as senses of touch, smell, taste, hearing and sight.

The lecturer dealt with these in turn, discussing fully the nature of the stimulus and the nature of the response to it. In this part of the lecture the Rev. Fr. Le Goc emphasized the fact that man combines the result of impressions and subjects them in the direction from which he received them and this direction, as in the case of the reflected candle in a mirror, may not be the true direction of the object. So far as the eye and the brain are concerned the " true " image and the " reflected " image are identical. A mirage in the desert, or as sometimes seen at the Straits of Dover is apparently a true image.

The lecturer held the sense of sight to be the reason for man's advance for all advance has been based on observations giving man a power over Nature.

The meeting terminated with a hearty vote of thanks to the lecturer which was carried with acclamation.

One Hundred and Third General Meeting

Minutes of the One Hundred and Third General Meeting of the Ceylon Natural History Society held on the 11th November, 1931, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President, Professor N. G. Ball, took the chair and there were 22 members and 2 visitors present.

The minutes of tho previous meeting were read and confirmed.

The following were elected members of the Society :—

Ordinary members.—Mr. J. R. Leembruggen.

Student-members.—Messrs. T. A. Frewin, J. A. L. Nelson, J. C. W. Rock, and L. Martinus.

The Chairman called on Dr. P. C. Sarbadhikari to give his lecture on " The Nature of Sex in Plants."

Dr. Sarbadhikari said that the existence of sex in plants was early recognised : it had been called one of the great mysteries, equal to that of life itself. That description was justified thirty years ago, but today it was so no longer, for in the last quarter of a century biologists had shed much light on the subject.

In the lower plants zoospore production is very general outside of the fission plants and it is very probable that sexuality had its origin in practically all groups at the naked motile stage of the life-cycle. In such plants as *Vaucheria* the difference in shape and size of the gametangia is remarkable who · the simplicity of the other parts of the plant is taken into consideration. In *Chara* the Oogonium and Antheridium are exceedingly complex and so remarkably differentiated in shape, size and finally in colour.

The Heterosporous Pteridophytes shown an extraordinary difference in the size of the sexual individuals. From the example of *Selaginella* it will be seen that there are two kinds of spore-cases, one bearing large spores (megaspores or female spores) and the other small spores (microspores or male spores).

Finally in the flowering plants, the great group of seed plants and the culminating group of the plant kingdom, the same conditions are carried forward to a greater extreme. Here the most complete expression of maleness and of femaleness is found. One of the most interesting cases in the change of the sexual condition is seen in the Papaw (*Carica papaya*). This is a dioecious species, but it has been found that if one of the staminate and therefore unfruitful trees has its terminal bud removed it soon begins to produce carpellate fruits. The differences between the male and female gametes, irrespective of any differentiation which may be present among those of either kind, are both physiological and morphological.

The meeting was thrown open to discussion and Professor Ellison asked whether in plants the same kind of difference in the male and female Chromosomes could be distinguished as in animals. The lecturer replied that as in animals the sex chromosome could be distinguished in plants. There being no further discussion the Chairman called for a hearty vote of thanks to the lecturer. This was carried with acclamation.

The meeting then terminated.

One Hundred and Fourth General Meeting

Minutes of the One Hundred and Fourth General Meeting of the Ceylon, Natural History Society held on December 8th, 1931, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President, Professor N. G. Ball, took the chair and there were 14 members and 2 visitors present.

The Honorary Secretary read the minutes of the previous meeting which were confirmed.

The Chairman called on Mr. P. Kirthisinghe to give his lecture on " Frogs, toads and their allies."

Mr. Kirtisinghe opened his lecture by explaining the course of evolution of the vertebrates and allocating to the Amphibians the Carboniferous and Permian periods, a position between the Age of Fishes and the Age of Reptiles.

An Amphibian such as a frog or toad is adapted to live the earlier part of its life in water when it possesses gills and breathes like a fish, but later it possesses lungs and breathes air like a reptile or mammal.

The Class Amphibia is divided into four Orders. Of these, the first Order, the Stegocephalia, is composed entirely of extinct forms whose remains are first found in the Cambrian but continue into the Permian. These are the first vertibrates to depend entirely on air breathing for part of their life. The fossils *Loxomma*, *Cricotus* or *Eryops* and *Melosaurus* show three stages in the development of the Stegocephalia. The first lived in water and swam with its long flat tail and it may have crawled on land with its short feeble legs ; the second type lived on dry land and probably only returned to water to breed ; while the third type probably found its dependence on water as a breeding place or merely to keep moist its skin which rendered it unfit to compete with dry-land reptiles and extended the larval period so that it became completely aquatic again.

The three remaining Orders, the Urodela, Anura and Gymnophiona are all recent and alive at the present day. The Urodela can roughly be divided into two groups, those in which gills are absent in the adult and those whose gills persist. Mr. Kirtisinghe described by means of lantern slides and actual specimens the main types of Urodela including *Amphiuma* of the South-east States of North America, the Salamanders, *Salamandra atra* and *maculosa* each with different breeding habits relative to its different habitat. *Ambystoma* and its precocious larva the Axolotl ; *Proteus* the Blind Salamander of Germany and *Siren lacertina* from North America.

The lecturer then described the Anura, dealing in particular with their breeding habits, describing first the development of the common Frog or Toad and showing how the other members of the group differed. *Racophorus reticulatus* attaches her eggs to the underside of her belly and the eggs are about twenty in number, while *Racophorus maculatus* lays her eggs in a frothy foam over a well or at the side of a stream and the young tadpoles on hatching drop into the water. *Alytes obstetricans* the mid-wife toad is peculiar for here it is the male that looks after the eggs attaching strings of them to his legs where they remain until hatched. The Brazilian frog *Hyla goldii* carries her eggs on her back, whereas in the Surinam toad *Pipa americana* from North Brazil, the eggs are carried on the back of the mother but her skin thickens so that each egg is enclosed in a dermal cell where it remains until the baby frogs emerge perfectly formed. In *Rhinoderma darwini* a small frog from Chili, the eggs are carried in the gular pouch of the father, the pouch extending over the entire ventral side.

The *Gymnophiona* are represented in Ceylon by *Ichthyophis glutinosa*, a worm-like Amphibian without limbs found in the Botanical Gardens at Peradeniya. In this case the gilled or larval stage is passed through in the egg before the young are hatched.

In conclusion Mr. Kirtisinghe discussed the ancestors and mode of evolution of the Amphibia dealing in detail with the similarities of the Amphibia and Lung-fishes with regard to their development, respiratory, circulatory, and excretory systems. He indicated the probable manner in which air breathing Amphibia evolved from gilled ancestors, supporting his theory by comparative morphology, palaeontology and embryology and showing the affinity between the Dipnoi or lung breathing fishes and the Amphibia.

In the discussion which followed Professor Ball, Mr. Wait, Mr. Burt and Professor F. O' B. Ellison took part.

The meeting terminated with a hearty vote of thanks to Mr. Kirtisinghe. This was carried with acclamation.

One Hundred and Fifth General Meeting

Minutes of the One Hundred and Fifth General Meeting of the Ceylon Natural History Society held on January 12th, 1932, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

In the absence of the President, Dr. Pearson took the chair and there were 86 present, of whom 19 members and 8 visitors signed the book.

The Honorary Secretary read the minutes of the last general meeting which were confirmed.

Mr. K. Martinus was elected a student-member.

Dr. Pearson called on Mr. Wait to give his lecture on " Birds' Eggs."

The fact that birds are evolved from reptiles is borne out by the characters of Archaeopteryx, which is, in a sense intermediate between these two groups. Birds being derived from a reptilian branch should show the ancestral characteristics of reptiles in their eggs.

Most reptiles lay unpigmented white eggs with a hard or a leathery shell which are usually laid in sand or earth and covered over. Birds without exception, lay eggs and have carried the evolution of the original reptilian egg to a high degree. Most birds build nests, some lay on bare ground while the Megapodes have retained or have reverted to the reptilian habit of laying their eggs in mounds and covering them over.

The outside texture of birds' eggs varies: soft and calcareous in the Cormorant, smooth and greasy in the Whistling Teel, glossy in the Kingfisher, smooth but dull in the White-vented Drongo, slightly pitted in the Mynah's egg as in the Ostrich or Pea fowl egg. The shape varies from the normal as in the House crow; pyriform as in the waders; peg-top shaped, symmetrical, round or pointed at each end.

The markings vary from self-coloured as in the Pond Heron, stippled in the Jungle Fowl, freckled in the Moor-hen, heavy blotched in the Painted Snipe, to scrawled in the Indian Kentish Plover. The relative size of the egg varies according to the degree of development attained by the chick when it is hatched and also according to the size of the clutch.

Mr. Wait discussed the evolution of colour from the white reptilian egg. Eggs found in dark holes or in closed nests are usually white but there are many exceptions. The white egg may be the original colour carried down without change or birds may have evolved pigmented eggs, some reverting to white as a modification to suit environment. This was illustrated at length by eggs protectively coloured, mimetically coloured eggs of parasitic cuckoos and the white eggs of birds of the Coraciiformes. Exceptions are seen in the pale blue eggs of the common Mynah which nests in the hole of a tree, the spotted egg of the Southern Grey Tit which is found in a similar nest and the white egg of the Ash Dove found in the scanty nest of a few twigs.

There is, however, no doubt that many birds, especially those nesting on the ground lay protectively coloured eggs. Some of these are the eggs of the Indian Pipit, the common Indian Night Jar, the Ceylon Bustard Quail, the Little Tern, and the Yellow-wattled Lapwing. The pinkish egg of the latter is particularly interesting as it is obtained from a locality where the soil is pinkish red laterite.

The lecturer then discussed the more elusive problem of the causes leading to the evolution of the various beautiful colours in eggs, neither white nor protectively coloured. Pycraft discusses the evolution of colour types in eggs referring it to the evolution of plumage and suggesting the inherent tendency to an increase of pigmentation in the eggs of certain birds. Natural selection acts as a sieve weeding out all such experiments if they become a handicap in the struggle for existence. In fierce birds and assiduous sitters there is little need for concealing colouration, and throughout the family of the Hawks and Eagles there are wide differences in the eggs. The Sea-eagle's egg is white, the Sparrow Hawk's egg has bold blotches of brown, while the eggs of the Honey Buzzard and Peregrine glow with colour.

The Warbler family gives many instances of specific, racial, and individual variation. All the members build skilfully constructed nests which are well concealed. In many the nest is domed so that the eggs are invisible from the outside. Eggs in cup-shaped nests (Ceylon Great Reed Warbler) are not conspicuously coloured. Nests almost tubular (Streaked Fantail Warbler) have

eggs of which the ground colour is white. Nests which are domed have pure white eggs. In other warblers with the same kinds of nests there is a wide range of vivid colour. The examples from the warblers which Mr. Wait showed suggest the following line of evolution in the nests and eggs: (1) The cup nest, the ancestral form, with protectively coloured eggs; (2) The tubular, cup, or domed nest with more vividly coloured eggs; and (3) The dark nest with whitish eggs, speckled and eventually pure white. In the Coraciiformes white is probably the ancestral colour, here it appears to be a recent modification.

Mr. Wait then discussed the eggs of the whole family of Bulbuls where a certain amount of variation is found in each species.

Another aspect of egg colour is warning colour and mimicry. Eggs of various species differ greatly in flavour, for the Robin, Swallow, and Nightingale have nasty tasting eggs; the eggs of the Little Bittern are sweet and mild, and the eggs of the Barn Owl not much inferior. The bright colour of eggs laid in open nests may be a flag of warning. The Pied Crested Cuckoo always lays blue eggs victimizing the nest of the Babbler and here the colour conveys some advantage, as the Koel, victimizing the Crow, has likewise a similarly coloured egg. The Cuckoos, belonging to the Coraciiformes, have diverged widely from the ancestral habit, the non-parasitic members still laying white eggs, as in the Jungle Crow.

In conclusion Mr. Wait discussed the structure of the egg, the process of egg laying, and the probable mechanism of the deposition of pigment illustrating the different types of markings with eggs from birds of widely separated families.

In the discussion which followed Professor Hill, Mr. Burt and Professor Ellison took part. The main point discussed was the pink colour of the egg of the Yellow-wattled Lapwing when found on laterite soil.

Dr. Pearson in paying a tribute to the lecturer, mentioned the Epidiascope which made possible the illustration of the lecture by the actual eggs. The meeting closed with a hearty vote of thanks to the lecturer.

Notes on the development of the leathery turtle, Dermochelys coriacea

BY

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(With Nine Plates)

Dermochelys coriacea (Linné) known as the luth, leathery or trunk turtle, Sinhalese Dhara käsbäva, is an outstanding herpetological curiosity owing to its peculiar structure. Little is known about its habits and even less about its development, for this animal seems to be very rare in other waters. It is apparently oceanic[1] and only enters coastal waters before coming ashore to lay. Hence the adolescent stages have not yet been obtained and only the newly hatched young and mature adults are known to science. Opinion has fluctuated as to its systematic position which has been discussed by me (Deraniyagala, 1930*b*), and my belief that it is the most primitive member of the order is shared by Dr. Malcolm Smith (1931), while several features here dealt with further support this view. It is advisable to have a knowledge of the more important features of this form prior to studying its development and for a detailed description with three plates see Deraniyagala, 1930*a*. In preparing this paper I must acknowledge my indebtedness to Mudaliyar and Mrs. E. Tillekeratne, Dr. and Mrs. J. D. L. Perera and Mudaliyar W. A. Goonetilleke for help in collecting specimens. The three 21-day embryos from Kalutara and the 32-day embryo from Bentota were examined under the instructive guidance of Professor J. P. Hill, of London University, in 1930. These four embryos were photographed and the negatives left in the collection of the Department of Anatomy and Embryology of London University. The present paper deals with embryos so far advanced as to show a constant number

1. According to Sinhalese fishermen the usual habitat of the turtle is in waters beyond the 27 fathom line where it is fairly common.

of somites. The very early stages are not available as yet. In view of this it is proposed to group such embryos as do not show any family characters as *Early*, while those which do will be termed *Late*.

Dermochelys, the largest living testudinate, is more highly adapted for aquatic life than any fossil or living member of the order. However, its anatomy reveals numerous characters which rank it as the most primitive of living Testudinata, and it differs so greatly from other families as to be ranked in a separate suborder by itself, the suborder *Atheca* Cope. The carapace consists of a mosaic of osseous platelets upon a thick layer of connective tissue supported by the nuchal bone, vertebrae and ribs which are free and do not form secondary expansions as in all other Testudinata. The plastron is with or without a few rows of vestigial osseous platelets upon a layer of connective tissue which is supported by eight splint-like bones which do not alter their proportions with age.

The genus *Dermochelys* Blainville, has seven longitudinal ridges on its carapace, five on its plastron. In the young the skin is broken up into numerous scales which are enlarged on the head and corselet ridges. In the adult the boundaries of these scales disappear completely from the corselet, although at times vestiges may remain elsewhere. Three pores occur on the corselet behind each fore limb. Two of these are supraaxillary, one is inframarginal.

The jaws show an anterior premaxillary cleft, bounded on each side by a triangular premaxillo-maxillary cusp followed by a maxillary cleft. Within the mouth are numerous, long, acute, fleshy papillae. The choanae open almost directly beneath the nares and the ear has no external aperture. The palaeorbital[1] skull has the supratemporal area roofed over, the para-sphenoid is strongly enlarged and there is a cartilaginous intertrabecula. Above the area of the nuchal bone is a distinct nucho-scapular hump supported by the tips of the columnar scapulae. The limbs are paddle-like, the anterior pair are elongate and at times one or two claws may be present, rudimentary in embryos and developed in the young only. The tail is compressed and rudder-like with a dorsal cutaneous crest which becomes somewhat reduced with age, while a wide cutaneous cruro-caudal fold develops and in the adult connects the tail with the posterior margin of each hind leg (Plate XX, fig. 4). The pelvis is noteworthy as being more primitive than even in such early fossils as the Amphichelidae.

The breeding range of this turtle appears to be 15° North and South of the Equator. Dumeril and Bibron obtained a young one in

1. The frontal bone does not enter the orbit as it does in the neo-orbital type of skull. See Plate XVII, fig. 2.

the Mediterranean which in all probability was transported thither from West Africa by currents.

Several batches of spherical soft-shelled eggs are laid annually by the same individual, these are white in colour but a batch from Bentota, April 19th, 1932, had all the normal eggs marked with small pale green spots. The chief laying months are May and June.

The turtle comes ashore at all hours of the night between 8 p.m. and 3 a.m. and the nest which is considerably deeper than those of the Cheloniidae is dug fifteen to twenty metres from the sea. The young frequently hatch out in daylight as seen from a nest full taken at Kalutara on the morning of June 28th, 1929, Vadduva on March 9th, 1932, Bentota, February 27th, 1932, and as reported from Bentota at 9 a.m. on August 29th, 1931.

In every nest ten to fifteen eggs are abnormal being oval, small or irregular. These contain albumen but no yolk and are infertile. Normal eggs range from 50 mm. to 54 mm. in diameter and weigh from 70 to 80 gms., and it is interesting to note that in every nest of embryos examined there were two eggs containing twins. This is noteworthy as such a condition has not been obtained either from the two batches of Eretmochelys embryos or from eight or nine batches of Caretta embryos, although both forms possessed abnormal specimens. The period of incubation is from fifty-eight to sixty-five days and varies with the intensity of the sun.[1] In the majority of cases the eggs were obtained immediately or soon after being laid as the flipper marks left on the sand by the mother testified. Such marks are usually obliterated by the wind in 24 hours. The eggs hitherto studied were in every instance, removed from the beach, transported considerable distances by rail or car and buried in ordinary earth, often after several days, thereby strongly affecting their latent period. Hence great discrepancies exist between age and embryo, dependant on the jolting, exposure and desiccation the eggs were subjected to. The shortest period of incubation recorded was in the case of eggs buried at Lunava on June 22nd, 1931, which hatched on August 18th, 1931, a period of 58 days, but several 60 and 62-day embryos have been obtained with a considerable yolk sac.

In the circumstances it has been deemed necessary to give two ages for each embryo, the total age and corrected age.

Sixteen eggs from a new nest were buried at Lunava, June 22, 1931, and yielded one 15-day embryo on July 6, 1931. This specimen seemed of normal age, as a single young one hatched out of the remain-

1. For description of incubation of eggs, see Deraniyagala (1930*a*).

ing eggs on August 18, 1931, an interval of fifty-eight days, the shortest incubation period hitherto recorded for this turtle, although a shorter period is known for the Cheloniidae which generally require sixty days, Caretta eggs laid on August 28 hatching on October 20, 1929. The newly hatched specimen was smaller than normal, its dimensions being as follows:—Head length 24 mm., length of carapace 54 mm., width of carapace 37 mm. A hare-lip on the left side admitted water into its mouth and the animal was drowned. In view of these facts the 15-day embryo should not be regarded as typical, as the eggs were probably influenced by some detrimental factor such as over exposure to the sun or rough handling. However, it is a useful index in ascertaining the correct age of what are otherwise normal ones more retarded in development.

EARLY EMBRYONIC STAGES

Eggs laid on June 28, 1929, at Kalutara South were transported by rail to Colombo, a distance of 25 miles and buried in the garden. They were dug up on July 18, 1929, and three embryos, designated A, B and D, in varying stages of development were obtained. These 21-day embryos were retarded in development and under normal conditions should probably be 10 to 18-day old stages as seen by comparison with the embryos obtained from Lunava.

Embryo A (Plate XII, fig. 1)

The smallest of these 21-day embryos which should probably be a normal 10-day form was the earliest stage examined and showed the following dimensions: Total length 5·5 mm., tip of snout to top of head 1·5 mm., axilla to groin 1·6 mm., depth over heart 1·4 mm.

The embryo was open ventrally from the pericardium to the caudal region ; the head was flexed with the snout nearly touching the cardiac protuberance, the mid brain was large and occupied the vertex of the head. The body was rather strongly arched and deep behind the head ; the tail was short, and as appears to be the usual condition in these early stages, bent upwards over the back. The olfactory pits formed shallow depressions on the ventral surface of the snout. The eye showed a well-developed lens, the chorioid fissure was distinct. Below and behind the optic primordium the fleshy maxillary fold was confluent with the mandibular arch and extended along the edge of the stomodaeum. There were four distinct external branchial grooves which decreased in size posteriorly while the last lay in a depression. Distally they tended to converge and roughly formed two triangles ;

the anterior and larger consisted of the mandibular and hyoid arches, while the two branchial arches formed the smaller triangle. The maxillary process was rather small with two slight prominences along its posterior margin. The mandibular and hyoid arches were large, the first branchial arch was nearly as wide as the mandibular but shorter, and the second branchial arch was very short. They were both contiguous with the cranial surface of the pericardial swelling.

At the posterior upper corner of both the mandibular and hyoid arches was a faint fleshy prominence which has been noted in several reptilian and avian embryos by other workers. These are thought to be vestiges of what were once external gills and will be termed branchial nodes in this paper. The shallow auditory pit lay above the second external branchial groove which separates the hyoid from the first branchial arch. The cerebral swellings were recognisable and a pineal prominence lay between the fore and mid brains, of which the latter occupied the vertex of the head. From the ventral edge of a well-marked fleshy lateral body wall fold arose a pair of anterior and posterior swellings. These were the limbs and were ellipsoid in outline, the anterior pair were considerably the larger. The body consisted of twelve mesodermal somites which were recognisable anteriorly to above the axilla with a further twelve from here to the base of the stumpy tail.

Embryo B (Plate XII, fig. 2)

The next stage which should probably be a normal 13-day form showed the following dimensions: Total length 7·5 mm., tip of snout to top of head 1·6 mm., axilla to groin 2·5 mm., snout to fore limb 3·5 mm., depth over heart 2 mm., depth at mid body 1 mm. The tail of this specimen had its tip broken off. The embryo showed more pronounced definition than in either the previous or subsequent stages and was markedly elongate. It was open from below the cardiac protuberance to the allantois; the head was proportionately smaller and the tail longer than before. It is possible that the change in the size of the head was largely influenced by shrinkage in 90 per cent. alcohol. A similar elongate stage appears to exist in the Cheloniidae as seen on examining embryos of *Caretta caretta*.

The cephalic flexure had now disappeared almost completely, but the body was gently curved in the cardiac region which had increased considerably in area. The tail was elongate and curved downwards ventrally. The allantois was nearly as large as the snout and had developed slightly anterior to the posterior limb buds. Its anterior half was distinguishable into a median and two lateral lobes.

(Plate XII, fig. 3). The body somites were conspicuous and equal in number to the previous stage.

The lateral body wall fold was distinct. The olfactory pits which were deeper and larger than before extended dorsally, while the rim of each had thickened. The eye which was as large as the olfactory pit, showed the chorioid fissure, while the optic rim had increased in thickness. Two prominences appeared on the maxillary fold, which bordered the wide open stomodaeum laterally and extended to the olfactory pit. The cardiac protuberance was remote from the snout. The visceral arches were at their maximum development, and showed branchial nodes on the mandibular, hyoid, and first branchial arches. The hyoid arch was as long as the mandibular but broader, and bore the most prominent branchial node. The auditory pit was larger and lay above the second ectodermal branchial groove. The cerebral divisions were very distinct, the rhinencephalon large. The swelling of the ganglion of the trigeminal nerve appeared behind the eye, while the pineal prominence, although smaller than before, was more conspicuous. The limb swellings had elongated into prominent buds, of which the anterior were larger than the posterior from which a connecting fold extended for about four somites along the base of the tail.

Embryo C (Plate XIII, fig. 1)

A 21-day embryo was obtained on July 4th from eggs laid at Kalutara on June 14, 1930. The specimen was intermediate between embryos (*b*) and (*d*) of the 1929 Kalutara embryos, and was probably a normal 15-day specimen. As it was bent into three curves its total length was only 4 mm., its other measurements were:

Tip of snout to end of fore limb 2·75 mm., tip of snout to origin of tail 3·4 mm., tail 0·9 mm., cephalo-nuchal curve (in a straight line) 1·5 mm., dorsal curve (in a straight line) 1·9 mm., blastoderm 10 mm. by 8 mm., area opaca 2 to 3·5 mm. in width. The thick tail was bent dorsally at right angles to the body which was open from the heart to the allantois. The roof of the head was shrunken in alcohol as in embryo B. The snout was remote from the cardiac protuberance and the body was strongly curved in the cardiac region and again near the anterior limb bud. The body somites were less distinct than in embryo B, but the lateral body wall fold and anterior limb bud were well developed. The olfactory pit had a thick rim and the chorioid fissure was open. The visceral arches had changed considerably in position, for the last two had rotated downward, making all the external branchial grooves

concentric. Branchial nodes were recognisable on the first three arches. The hyoid arch was broader and stronger than the mandibular. At the dorsal end of the ectodermal branchial groove between the hyoid and first branchial arches was an ellipsoid prominence, the rudiment of the auricular process behind which was the inconspicuous auditory vesicle.

The two branchial arches were small and depressed. The heart was external and formed a double loop. The cerebral divisions were distinct, the pineal prominence was conspicuous and the mid brain formed the vertex of the head.

Embryo D (Plate XIII, fig. 2)

The largest of the Kalutara 21-day embryos of June 28, 1929, should probably be a normal 18-day form. The dimensions were total length 9·6 mm., tip of snout to mid brain 2·6 mm., axilla to groin 3·5 mm., depth over heart 2·9 mm., depth at mid body 1·5 mm., snout to arm 5 mm. The embryo was open ventrally from below the cardiac protuberance to the allantois which was still trilobed, the head was more flexed than in the previous stage, while the snout and brain had enlarged, the body was slightly curved but the cardiac prominence was remote from the snout. The neck was short and thick, the tail stumpy and bent upward over the back. The entire embryo was decidedly more thick-set than hitherto and the snout had begun to elongate and widen. The olfactory pits had decreased in size ; they were sunken and somewhat smaller than the eye, and showed a pronounced rim, while the maxillary fold extended ventrally to each pit. The eye was unpigmented.

The visceral arches had expanded, the branchial groove between the mandibular and hyoid had begun to disappear, while the branchial nodes were well developed on all, those on the branchial arches were more central in position than before. The maxillary existed as a round knob from which the maxillary process emanated and proceeded anteriorly along the ventral side of the snout. The cerebral divisions were indistinct and not as raised proportionately as in the Cheloniidae at a similar stage. The pineal prominence was more conspicuous than hitherto but smaller. The ear was reduced and had sunk. In front of it was the swelling of the auricular process. The limb buds had bent over and now touched the body and the anterior buds were far more advanced in development than the posterior. The body wall had thickened laterally. Segmentation was less distinct than in the previous stage and the anterior somites of the neck were

considerably reduced. As yet there were no signs of the future carapace. The allantois appeared to be proportionately smaller than in the previous stage and was slightly smaller than an anterior limb bud.

Embryo E (Plate XIV)

Eggs laid at Lunava, Western Province, on the night of August 11th, 1930, were transported by car to Colombo, a distance of 12 miles. Five comparatively uniform 21-day embryos were obtained on September 2nd, 1930. These were far in advance of the Kalutara embryos of the same age and nearer the normal 21-day stage.

The dimensions of these 21-day Lunava embryos were as follows: Total length 12-12·5 mm., depth of head at eye 4-5 mm., eye 2·5-3 mm., lens 0·8 mm., depth at heart 5 mm., top of head to arm 7 mm., axilla to groin 5 mm., fore limb 2·9-3 mm., hind limb 2·25 mm., tail 5 mm.

The blastoderm had spread over most of the egg surface. The allantois which in the specimen here figured was torn off and separate, had mushroomed out under the extensive false amnion to occupy an area about as large as the head of the embryo.

This stage was far in advance of the previous ones and completely closed ventrally with the umbilical stalk in the posterior third of the plastral area. The head did not touch the cardiac protuberance and the strong tail was coiled up ventrally in a vertical plane between the hind limbs. The head was enlarged, with prominent, globular pigmented eyes which were lidless as yet. The chorioid fissure had closed. A conspicuous subocular sulcus best defined along the posterior edge of the eye was present. The neck was also thick and strong.

The nasofrontal process was subconical, but when the specimen was placed in 90 per cent. alcohol this flattened and later assumed a median depression. Each olfactory capsule, although greatly deepened, had not closed its rim, which was distinctly raised and consisted of the nasofrontal process anteriorly and the lateral nasal process posteriorly. The lachrymal groove, which ended in the stomodaeum, lay between this and the thickened maxillary fold. The oro-nasal groove was well defined. The stomodaeum was large and bounded below by the mandibular arch. The branchial grooves and nodes had disappeared. A well marked precervical sulcus, with a fleshy fold along its anterior edge, was present above the cardiac protuberance and ended in a small pit laterally. On the anterior edge of each pit was a prominent fleshy node, the vestigial opercle. The brain was well developed but not as conspicuous as in the Cheloniidae at a similar stage. The pineal area was faint. The swelling of the columella auris was prominent, above it lay the thickened

semilunate auricular process which also exists in the Cheloniidae. There was a distinct shoulder plate on each side of the pericardiac area ; the limbs showed recognisable joints and consisted of a cylindrical basal shaft with a depressed terminal disc. The previously mentioned lateral body wall fold lay above the limbs, while a less developed ridge appeared above this. Both were confluent posteriorly to form a distinct lateral iliac prominence above the hind limb. The sudden decrease in width behind these two iliac bumps was very noticeable, and at this stage the first indications of a testudinate shape began as a perceptible expansion of the body. As yet there were no anterior or posterior boundaries of the carapace. Two indistinct ventral ridges were also recognisable. The genital prominence was well developed and protected by the strong subcylindrical tail which was generally coiled on itself in a vertical plane between the hind limbs. The tail when partially extended usually displayed a definite kink at the tip, and this condition is probably a reptilian characteristic as embryos of the logger head, *Caretta caretta*, and of the Hawksbill turtle, *Eretmochelys imbricata*, from Karaduva, December 28 to January 24, 1931, aged twenty-eight days showed a similar condition. Embryos of *Crocodylus porosus*, which had just begun to develop pigment showed the extreme tip of the tail twisted and bent upward and forward. A newly hatched Dermochelys from Vadduva (W.P.) March 9th, 1932, showed as prominent a caudal kink which persisted until its death on April 22nd, 1932 (Plate XX, fig. 1).

Embryo F (Plate XV, fig. 1)

Eggs obtained at Bentota on August 31st, 1928, were sent to Colombo by rail, a distance of 40 miles. They were buried in the garden on September 3rd, 1928, and the first embryo fixed in Bouin on October 1st, 1928. The total age is 32 days which is corrected by deducting five days which consist of the night when laid, the day of fixation and the three days' delay before re-burial. Judging from the 21-day Lunava embryos just described the corrected age should be less than 27 days and is more probably 24 days. The dimensions were: Total length 13 mm., depth of head at eye 5·5 mm., eye 2·8 mm., lens 0·9 mm., depth of body 6·5 mm., head and neck 8·5 mm., axilla to groin 6 mm., fore limb 3 mm., hind limb 2·9 mm., length of carapace 8 mm., tail (curved) about 7 mm. The living embryo was hyaline with dark eyes pigmented even upon their columnar bases. The dorsal and ventral corselet ridges were white, and of the former the inner three were continued on to the neck. The embryo was now recognisable as Dermochelys. The large head was strongly flexed on to the cardiac protuberance which, although

no longer markedly prominent, had a distinct shoulder plate on each side. The snout was thick and subconical with the reduced anterior nares, which had well defined rims, placed dorsally and rather further apart than in the Cheloniidae at a similar stage. The eyes were at their maximum prominence and were also more globular than hitherto, while the faint rudiment of an eyelid was present ventrally. The subocular sulcus was deep, especially along the posterior margin of the stalk-like eyes. The maxillary folds had fused with the palate and the lateral nasal process had fused with the nasofrontal process bridging the oro-nasal groove to form a passage from each olfactory pit to the mouth. The mouth was as wide as in the preceding stage but more slit-like and less open. It stretched down nearly to the cardiac protuberance, while the rudiment of the triangular premaxillo-maxillary cusp so characteristic of this turtle was present. The lower jaw, which was much smaller than the upper, failed to close the mouth. It was contiguous with the cardiac protuberance from which the snout was remote. The auricular process lay around a definite prominence caused by the columella auris which was located above the angle of gape. The precervical groove and its terminal pits were indistinct. The limbs had begun to assume the definite paddle shape of the adult. Their terminal plate-like expansions had spread upwards along the columnar bases giving them a depressed shape, while digital divisions were recognisable in the fore limbs which were slightly longer than the hind limbs. A heavy lateral fold, which formed the margin of the carapace and ran into the iliac protuberance, lay above the limbs. Another pair of less well defined longitudinal ridges lay above this fold. The carapace had no anterior and posterior boundaries, and was confluent with the neck and tail respectively. The anterior line of demarcation is not as evident even in the adult as in other testudinates, as the head and neck are not retractile. The plastron possessed two faint longitudinal ridges. The strong subcylindrical tail curved over the conspicuous genital prominence and touched the plastron near the umbilical opening which was approaching a mid ventral position. Sections of this embryo showed the tissues differentiating from the mesoderm. The inter-trabecular cartilage was distinguishable and a wax reconstruction of the pelvis revealed a flat pubic plate which rested on the plastron by means of three short projections. The pubic plate consisted of two cartilaginous bodies which united posteriorly and were enclosed in mesodermal tissue. Posteriorly this plate became V-shaped in section and carried two foramina, each of which represented the future lateral ischio-pubic or obturator foramen. The ischiadic portion of the plate bent slightly downward and

was also V-shaped in section. Each ischium was represented by a small prominence near each acetabulum.

LATE EMBRYONIC STAGES

Embryo G (Plate XV, fig. 2)

Several dead embryos arrested in development were obtained from a nest where some eggs had already hatched out at Kalutara North, September 3, 1929. The youngest of these, embryo G, although badly preserved with the head flattened on one side, shows a distinct advance on the stage already dealt with.

Its dimensions were :—Total length 14 mm. (curved), length of head 8·8 mm., depth of head at vertex 5·6 mm., the eye was distorted and 4·5 mm. long, 3·7 mm. deep ; length of snout 1·9 mm., length of lower jaw 4·2 mm., length of neck 5 mm., length of fore flipper (to wrist) 7·4 mm., length of carapace 11·5 mm., depth of carapace 5 mm., depth of body 10 mm., axilla to groin 6 mm., length of supracaudal part of carapace 1·5 mm.

Lepidosis was absent but dark pigment covered the interspaces of the carapace, of which the neural bands were lightest. The white costal band advanced a short distance along the neck, the white neural band was indistinct and lay in a vertebral groove.

The snout was thick and well developed and had at its tip the rostral caruncle which carried a single point which later functions as an egg tooth. The eyes, which were probably globose, showed the rudiment of an eyelid along the lower posterior margin. The columella auris was well defined and more rod-like than hitherto and projected from the surrounding fleshy auricular process which lay above the base of the lower jaw. The gape ended just under the hind edge of the orbit and the mandibular rami were compressed together near the symphysis which was not curved upward. The neck was long, strong and cylindrical. Seven segments were distinct, while the eighth merged into the carapace area. Although a thickened edge defined its margin the carapace was still fully confluent with the neck and tail. Nine ribs were easily recognisable, of these the first pair did not extend beyond the white costal bands, whereas the others reached the margin of the carapace. The iliac protuberances were strongly developed. Each consisted of a round knob on the carapace margin and was contiguous with the ninth rib. Posterior to these the carapace was markedly constricted and depressed to form the supracaudal area which was entirely confluent with the tail. The limbs which were now definite flippers had begun to assume adult proportions, the anterior being

much longer than the posterior pair. As the tips of the digits were distinct each limb had a palmate appearance. The right hind flipper overlapped the left to cover the base of the tail which was elongate, curved under the right hind flipper and ended near the right groin. The tail was compressed dorsally and possessed a terminal kink. Comparison with embryos of known age places this specimen as a 26-day old embryo.

Embryo H (Plate XVI, fig. 1)

Eggs obtained at Kalutara, May 14, 1929, were opened on June 12, 1929. The total age of the embryo was twenty-nine days, the corrected age twenty-seven days. Its dimensions were: Total length 31 mm., head 12 mm., eye 5 mm., length of carapace 23 mm., width of carapace 14 mm., axilla to groin 12·5 mm., fore limb 10 mm., hind limb 7 mm., tail 7·5 mm.

The embryo was entirely covered with pigment which was faint. The seven white carapace bands were each as wide as a third or half of one of the greyish brown interspaces. The white neural band was interrupted after an orbit length behind the neck, then resumed for a short distance equal to a fourth of the orbit, interrupted again, then continued to end of carapace. In the preserved specimen the white was inconspicuous on the neck. Pigmentation was much lighter ventrally than dorsally. Lepidosis was nearly complete upon the carapace, rudimentary above the eyes and around the margin of the plastron, but unrecognisable elsewhere.

The embryo was almost straight without a conspicuous cardiac protuberance. The snout was shorter than the eye ball and conical with a rostral caruncle carrying the point which later functions as an egg tooth. The nostrils were small, set wide apart and located above this rostral point. The eye no longer showed the stalked appearance but was still globose and about one-fourth the size of the head. Dorsally it was fixed to the skin for one-sixth of its diameter, the remaining five-sixths were encompassed by an annular eyelid which was best developed ventrally. Around the pupil was a ring of ectodermal placode-like thickenings [1] from which arise the future sclerotic plates, which eventually lie on the sclerotic cartilage. The gape ended slightly behind the eye. The ear was subdermal; the upper jaw showed the premaxillary and maxillary notches distinctly, although the premaxillo-maxillary cusps were not as long or acute as in later stages. The lower jaw now

1. A placode is a thickening on the under side of the ectoderm, these, however, are external prominences.

completely closed the mouth cavity and the mandibular symphysis was curved. The neck was now separated from the carapace which had well defined boundaries with thick, fleshy lateral margins and a short triangular supra-caudal projection. The plastron showed an anterior epiplastral swelling from which the plastral ridges extended posteriorly.

The limbs had developed, the anterior pair did not reach the groin. The tips of the second, third and fourth digits formed prominences on the margin of each limb. The tip of the fore flipper was broadly triangular in outline. The posterior edges of the hind limbs did not overlap as they did in the previous stage and do later, but lay on each side of the thick subcylindrical tail which, although feebly compressed dorsally, did not show the dorsal crest. The tail which was not coiled up was proportionately shorter and more remote from the plastron than hitherto. There was a pronounced increase in thickness and it was somewhat longer than the hind flipper. It curved over the strongly developed genital prominence.

Embryo J.

A 51-day embryo from Bentota eggs, August 31st to October 20th, 1928, appeared to be three days slower than normal in its growth. An egg from this batch when opened on the sixty-second day yielded an embryo with a yolk sac considerably larger than its head. Hence the corrected age is forty-eight days. The dimensions of the embryo, which was straightened out prior to fixation in Bouins, were: Total length 65 mm., head 19 mm., eyeball 7 mm., carapace length 45 mm., carapace width 30 mm., axilla to groin 23 mm., fore limb 34 mm., hind limb, 15 mm., tail 10 mm.

At this stage the sclerotic thickenings had disappeared and a distinct nucho-scapular hump had appeared over the area of the nuchal bone and the terminations of the scapulae. This hump persists throughout life and develops in the adult but becomes inconspicuous with age. Lepidosis and pigmentation were more or less complete but not as intense as in the newly hatched. Generally speaking, the embryo does not undergo any marked change of shape or colour from now until hatching.

Pigmentation differed from the newly hatched in being fainter, and in that the top of the head was lighter than elsewhere dorsally. At this stage the white carapace bands were as wide as a fourth or fifth of the black interspaces. The neural band was narrower than the others until it passed behind the nucho-scapular hump. The inner

three carapace bands continued along the neck as single rows of white spots, while two similar bands lay in between. A single dorsal row of six white spots ran along the tail. The embryo was white ventrally with dark pigment in the interspaces between the outer pairs of plastral ridges. This dark pigment was vague or absent anteriorly in the epiplastral area. Lepidosis was complete. The head scales were conspicuously enlarged but less so than in the Cheloniidae. The scales of the corselet ridges were not quite twice as large as those on the interspaces which were subequal. The head scales at this stage were smooth and more readily distinguishable than in newly hatched specimens in which they are so thick as at times to bridge their divisions at numerous places. Their arrangement was as follows: Prefrontals one or two pairs, frontal single or represented by numerous small scales in a longitudinal series; when single this scale may be confluent with the single frontoparietal. Temporals small, in three or four longitudinal rows; parietals two or azygos. Occipital either single and distinct or confluent with parietals which are then azygos. Preoculars three or four, conspicuous. Supraoculars five to eight, wide, short. Postoculars eight to ten, small. Throat scales small with a row of fourteen to eighteen enlarged postmandibular scales, which may be interrupted in the middle behind the symphysis. Carapace consists of numerous small *polygonal* scales traversed by seven longitudinal rows of larger *subquadrangular* scales in single rows of 21 to 25 on the supramarginals and 28 to 35 on the others. There are four or five longitudinal series of the smaller polygonal scales between each pair of these carapace ridges. The marginal scales posterior to the groin were prominent and formed a serrate edge. The supracaudal portion of the carapace was complete as a narrow subrectangular projection which bent downward. The plastron had five longitudinal ridges and the general arrangement of its scales was as in the carapace. The median ridge, however, consisted of two rows of scales. The head was proportionately smaller and the snout, which was as long as the eyeball, was markedly overshot and flattened ventrally. The rostral caruncle was more conspicuous and the ventral area of the snout broader than the dorsal part where the nostrils lay. These were as remote from each other as in the newly hatched. Numerous characters now appeared which are seen in the adult. The premaxillo-maxillary lateral cusps were more acute than before and slanted obliquely backward, although in the adult they are nearly vertical. A distinct internal ridge ran parallel with each maxillary margin forming a slot to receive each mandibular edge of the lower beak when the mouth was closed. The inside of the mouth was covered with the oral papillae which are so developed in

the adult, while the eyelids met at an almost vertical plane. The fore limb had elongated considerably and in the straight embryo its tip reached the groin, but as it lay naturally, curved over the yolk, the tip of each flipper was folded inward upon itself and tucked away under the hind limb, which had the same proportions as before. although its margin was less palmate. The left hind limb overlapped the right and they completely roofed over the tail which was no longer visible from above. The tail was considerably shorter than the hind limb and distinctly compressed, while its characteristic dorsal crest was recognisable distally where alone lepidosis was still indistinct. The genital prominence, which now possessed a terminal papilla, had begun to retract into the cloaca.

Twin Embryos (Plate XVI, fig. 2)

Two nests of mature embryos were examined. Each yielded two eggs with twin embryos, while a putrid egg from a batch buried in the garden also contained twins, of which the smaller had merely the vestige of a lower jaw. The twins usually differed considerably from each other in size but in one instance the pair were almost uniform. They generally appeared at opposite poles of the yolk and were connected by the allantois. The lesser embryo in some cases had a small yolk sac pinched off from the main yolk but was always connected to the latter as well.

Two examples are here described. The first was from a nest at Kalutara North. September 3rd, 1929, where some eggs had already hatched out. Both twin embryos were normally coloured, but the smaller one had narrower white dorsal bands and fewer and smaller white spots on the head and bases of limbs. The lepidosis was complete in the larger one which had a continuous row of postmandibular scales but less definite on the head, limbs and tail of the smaller one. In both the genital prominence[1] had retracted completely and a well-developed point was present on the rostral caruncle, while the tail was furnished with a caudal crest. Their dimensions were :—

	Large twin	*Small twin*
	mm.	mm.
Total length	75	50
Length of carapace	53	34
Width of carapace	37	24
Length of head	22	16
Length of fore limb	52	31
Axilla to groin	30	20
Yolk sac	$36 \times 30 \times 20$	$9 \times 6 \times 10$

1. It is probable that both were female embryos.

A similar egg from a nest of advanced embryos discovered at Bentota, March 30, 1931, showed the embryos at opposite poles on the yolk (Plate XVI, fig. 2). In this egg the lesser embryo had no small supplemental yolk sac as in the Kalutara egg. Lepidosis and coloration were very similar to the previous case, and it is of interest to note that here also the larger embryo had a continuous row of post-mandibular scales. The caudal crest was rudimentary in the larger specimen and absent in the smaller. The eyelids were complete and the genital prominence completely retracted. Their dimensions, together with those of a normal embryo, are given below :—

	Large twin mm.	*Small twin* mm.	*Normal* mm.
Total length (curved) ..	52 ..	22 ..	64
Length of carapace ..	38 ..	18 ..	45
Width of carapace ..	25 ..	8 ..	30
Length of head	18 ..	9 ..	21
Length of fore limb ..	33 ..	11 ..	35
Axilla to groin	20 ..	9 ..	21

The common yolk sac of the twins was 39 mm., that of the normal embryo being 43 mm. Calculating from the normal embryo the age was probably about forty-eight days.

OSSIFICATION

Ossification was studied in four embryos of unknown age and in five matûre ones, of which four were from a nest where some eggs had already hatched. The method employed was a modification of the Spalteholz process. The embryos were immersed in a solution of alizarin and potash, the flesh destained in alcohol, then cleared in glycerin which showed the osseous parts stained a bright red. Embryos II, III and IV were stained together in the same solution.

Embryo I

Total length 33 mm., head length 12·5 mm., carapace 22 mm. The membrane bones of the skull were rudimentary and remote from each other. Each lanceolate premaxillary was remote from the other and from the well developed maxillary which curved upward like the blade of a scimitar. The frontal bones were bounded externally throughout their anterior halves by the prefrontals which were far from the postfrontals. At this stage the rim of the orbit had two conspicuous gaps, one at each end of the prefrontal bone ; one anteriorly between the maxillary and prefrontal, the other dorsally between the prefrontal and postfrontal. The latter was nearly contiguous with

the jugal. Each frontal and parietal bone was widely remote from its fellow of the opposite side. Ossification began from the external margin of each bone and spread inward towards the mid-cephalic line. The bones of the lower jaw were in an advanced stage of ossification. The nuchal bone was no wider than the neural carapace ridge under which it lay and the basidorsal and basiventral elements of those vertebrae other than caudal, had begun to ossify. The ribs were ossified from the vertebral column to under the supramarginal carapace ridges, while the first pair which were vestigial only reached the costal ridges.

The plastral elements were plainly visible as splint-like bones which were remote from each other. The limb girdles had begun to ossify and the distal end of the humerus and the ulna and radius, together with the metacarpal bones and three of the basal phalanges were ossified. A similar condition existed in the hind limb.

Embryo II (Plate XVII)

Total length 41 mm., head 15 mm., carapace 29 mm. The skull bones were wider (fig. 2) and the bones of the palate conspicuous but widely separate from each other.

The proportions are rather similar to embryo I. As the lower jaw bones showed nothing noteworthy they are omitted from the figure. The orbital rim was still open while the eyeball showed a distinct dent on its ventral edge where the chorioid fissure once existed. The squamosal lay as a curved rectangular bone above the quodrato. jugal which was hammer-shaped with the handle pointing downwards. Both bones were remote from each other and the remaining skull bones (fig. 3).

Plate XVII, fig. 1, shows a ventral view of the palate. The prevomer is a narrow splint-like bone with a bifid head anteriorly. A median ridge is present and the bone is deeply forked for the posterior third of its length which ends in two acute points. These reach as far back as the anterior quarter of the palatine bones which are curved over near their external margins. The cleft prevomer is of special interest because it is a probable indication of the dual origin of this bone for the Testudinata have but a single prevomer,[1] whereas other reptiles have two.

The somewhat rounded parasphenoid lay between the pterygoids, each of which gave off two or three small, acute processes anteriorly. The thyreoid cornua of the branchio-hyoid plate were also ossified.

1. According to Broom and Brock (1931) the mammalian vomer is derived from the parasphenoid, whereas the prevomers of reptiles are homologous with the paired bones which form a dumbbell shaped bone in Ornithorhynchus and are not vomers.

The nuchal bone was distinctly anchor-shaped but without any acute lateral processes. It was now wider than the neural ridge. The plastral bones had begun to give out processes and the hyo- and hypoplastra were most advanced in this respect. The limb girdles showed more distinctly than before.

Embryo III

Total length 42 mm., head 16 mm., carapace 30 mm. The orbital rim had closed into a complete bony ring formed by the contiguity of the prefrontal with the maxillary and postfrontal. The eyeball still showed the ventral chorioid dent noted in embryo 2. The frontal bones nearly met one another at the mid cephalic line but the parietals were still remote. Each maxillary bone curved downward anteriorly to form a hook-like process as in the adult, see Smith (1931), fig. 6. The bones of the palate were nearly contiguous. The forked prevomer reached as far back as the posterior quarter of the palatines which were now contiguous with the pterygoids. The anterior caudal vertebrae had begun to ossify.

Embryo IV

Total length 45 mm., head 16 mm., carapace 33 mm. The ossification of the head was far advanced. The premaxillaries were lump-like and did not descend as far down as the anterior hook-like process of each maxillary. The prevomer, which was still forked posteriorly, had reached the pterygoids. The squamosal and quadrato-jugal had united to form a curved upper border to the ear, but remained separate from the rest of the skull, although the former bone was now close to the parietal. A distinct sclerotic ring[1] of fourteen subquadrangular osseous plates lay on the eyeball and were best developed ventrally. Three of these at the antero-dorsal area of the eye were rudimentary (Plate XVIII, fig. 1). The nuchal bone gave out anterior processes which reached the costal ridges. Nearly all the caudal vertebrae had ossified. The limbs showed all the phalanges ossified but no carpal or tarsal bones were noticeable as yet.

1. All the Ceylon genera of Testudinata possess imbricate sclerotic plates which are subject to numerical reduction and may or may not have marginal suttres. They are best developed in Dermochelys, Geoemyda and the Cheloniidae. In the last the placode-like ectodermal thickenings, rudiments of the sclerotic plates are well developed when the eyelids exist as a thin marginal annulus round the eyeball of the 27-day embryo. This was seen in *Caretta caretta* which has ten to fourteen such. In Geoemyda the plates do not form sutures as in the other two genera but they are more strongly curved. In Lissemys and Testudo the plates are less well developed. A single specimen of each form was examined and showed the following numbers *Chelonia mydas* (Linné) 11) *Eretmochelys imbricata* (Linné) 13, *Lissemys punctata granosa* (Schoepff) 14, *Testudo elegans* (Schoepff, 11, *Geoemyda trijuga thermalis* (Lesson) 10. It is probable that the maximum number in each case is 14.

Embryo V

The mature embryo ready to emerge from the egg showed that endoskeletal ossification was nearly as complete as in the adult, but there was no trace of the mosaic of carapace bones. The skull was compact, its solid lump-like premaxillaries had elongated downward along the hook-like anterior process of the maxillaries to complete the pointed premaxillo-maxillary cusps. The squamosal had united with the parietal. The prevomer was no longer forked posteriorly. The full number of sclerotic osseous plates as seen in embryo IV is 14, but they are sometimes reduced to as low a number as seven, and both eyes usually had an equal number. These plates were now contiguous and the median ones imbricate. Frequently there was a gap in the ring of bones antero-dorsally. This was about as wide as a seventh of the diameter of the bony sclerotic ring which was bounded at each end by a bluntly triangular plate (Plate XVIII, fig. 3). Out of five mature embryos, two showed completely closed sclerotic rings which consisted of twelve and thirteen plates respectively (Plate XVIII, fig. 2). The others, which had seven to twelve bones, showed the antero-dorsal gap. Later the plates expand sufficiently to form a complete ring. In the two adult females, whose dimensions are given, there were twelve subimbricate plates which were longest at the dorsi-ventral axis of the eyeball. In one turtle, two plates appeared to be fused, thus making the original number thirteen and the plates were sutured together (Plate XVIII, fig. 4). While in another adult female there were 9 plates in one eye, 11 in the other.

In the embryo the limbs showed ossified phalanges, metacarpals and metatarsals also the radiale, ulnare and pisiform carpal bones. The last was disc-like and many times as large as the other two. The limb girdles had completed ossification and in the pelvis the ischiadic portion was proportionately much shorter than in the 24-day embryo. All the ribs and caudal vertebrae had ossified, the former now reached the marginal ridges of the carapace. The anterior processes of the nuchal bone did not extend beyond the costal ridges. The plastral bones overlapped as in the adult, with the exception of the hyo- and hypo-plastra. These do not do so until after birth as the embryo is flexed in a line which runs between these bones. In the adult, one of the hyo-plastral bones is usually without one of the two anterior processes present in its fellow. This peculiarity is at times present in the embryo, but generally appears to develop after birth (see Deraniyagala, 1930*a*).

EARLY POST-EMBRYONIC DEVELOPMENT

Development has been studied in five newly hatched specimens for periods of 17, 38 and 62 days respectively.

The animal hatches between fifty-eight and sixty-five days after oviposition. The dimensions are :—Total length 85 mm., head 24 mm., carapace length 58-60 mm., carapace width 36 mm., axilla to groin 28 mm., fore flipper 58-60 mm., tail 12 mm., living weight 32·62 to 33·57 gms. In side view the nucho-scapular hump shows distinctly, behind this the carapace arches, then descends to the pelvic region to form another small hump-like prominence and terminates as the supra-caudal portion which is bent gently downward. Viewed dorsally the animal narrows just behind the shoulders and the sides are concave. The costal and marginal carapace ridges are more conspicuous than the others and the carapace margin posterior to the groin is noticeably flared out, and rather serrate. the plastron does not project anteriorly beyond the carapace and at this stage the scales are thick and prominent. The fore limb is as long as the carapace and its tip is elliptical in outline, whereas in the adult it is acute. One or two rudimentary claws may or may not be present on the first and second digits respectively of any of the limbs. The dermal fold, which in the adult broadly connects each hind limb with the tail, is feebly developed (Plate XX, fig. 3).

Newly hatched Dermochelys dive easily and swim rapidly with long downward sweeps of their relatively enormous fore flippers, while the hind limbs act mainly as balancers. In Cheloniidae,[1] the newly hatched young paddle mainly with the hind flippers and balance on the fore flippers. Observation of 40 and 62-day old Dermochelys showed that when moving fast it employs only its fore flippers and spreads out the hind limbs in a horizontal plane to act in the dual role of rudder and balancers. It is probable that the wide cruro-caudal membrane so characteristic of this turtle is evolved for the latter purpose (Plate XX, fig. 4).

Pigmentation is an intense blue black dorsally, while the five inner carapace streaks of white are much narrower than before and the encroaching black imparts to the white pigment a bluish appearance. The neural band is more reduced than the other carapace bands and the scale behind the nuchal hump is generally black or nearly so. The plastral ridges are white, their interspaces dark.

A feature of interest is the umbilical groove which in the 43 and 62-day specimens examined after death was found to extend as a long

1. They are unable to dive until several days after birth. See Deraniyagala (1930 *a*).

slit equal in length to the eye opening. Within the slit on its right wall was a round cavity which extended into the body.

The suborder Atheca was defined as "clawless" until in 1929 it was discovered that a certain proportion of mature embryos possessed rudimentary claws, and in one specimen they attained to full development within 17 days from birth (Deraniyagala, 1930*a*). Eighty-five embryos from a Kalutara nest in which some of the eggs had already hatched were examined. The head lengths ranged from 18 to 25 mm. and rudimentary claws were noticed on the first or first and second digits only. One had a claw on the right fore flipper, two had a claw on the right hind flipper, fourteen had a claw on each hind flipper, the remainder were clawless. One of the newly hatched specimens lived for seventeen days, September 3rd to September 19th, 1929, and developed two claws on each fore flipper but none on the hind limbs. As the animal was rather badly preserved in alcohol the claws dropped off. A section of its carapace treated with alizarin showed no trace of ossification. The animal's dimensions were :—Total length 98 mm., length of carapace 67 mm., width of carapace 39 mm., length of plastron 52·5 mm., length of arm 55 mm., axilla to groin 30 mm., length of head 25 mm. This specimen is now in the British Museum where there are two other young ones which are clawless. Four others kept for 38 and 62 days failed to develop claws. In two specimens every flipper had two pits, one above each of the terminations of the first and second digits. These pits were formed by the excrescence of the two marginal scales which enclose the claw when this is present. Specimen No. 901 of the Museum d' Histoire Naturelle, Paris, captured by trawl in the Mediterranean is 140 mm. long, the length of carapace 75 mm., its head 26 mm. This is the original figured by Dumeril and Bibron.[1] The left fore flipper showed a cavity corresponding in position to the claws of the Ceylon specimens ; namely between the dark scales which interrupt the white anterior margin of the flipper. Claws are not constant in their development and may be present in only a few young specimens.

The turtles fed readily on chopped fish although they did not thrive on this diet. The 17-day specimen has already been dealt with. The 38-day ones consisted of two turtlets kindly obtained by Mudaliyar W. A. Goonatilleke. They were hatched on the Bentota beach on October 10, 1931, and were received when seventeen days old on October 27, 1931. Their dimensions in each case were :—Total length 100 mm., length of carapace along neural ridge 71 mm., width of carapace

1. Dumeril and Bibron—*Erpétologie générale*, 1834-1854. t. 2. ,p. 560.

49 mm., length of plastron 61 mm. and 63 mm. respectively, arms tip to tip 158 mm., axilla to groin 36 mm., head length 25 mm. As the sea water in which the animals were sent had been spilt, fresh water had been substituted during transit. In consequence they arrived in Colombo in an enfeebled condition and small patches of scales had loosened from the corselet and limbs. On arrival the turtlets were at once placed in sea water and soon recovered. As is usual with this fast swimming form both had damaged their snouts and even the anterior margins of their fore flippers by striking against the tub in which they were kept. Hence it was impossible to ascertain whether they would have developed claws ; the hind flippers had none.

Pigmentation was very similar to the newly hatched. However, the white flipper margins were rather reduced, the white corselet ridges more distinct and the interspaces of the plastron darker.

The rostral caruncle, the embryonic lines of flexure and the wrinkled, skinny appearance had disappeared.

The snout was less acute, while the body which in newly hatched and adults is deep and somewhat compressed had now become markedly depressed, with a broadly elliptical outline as in the Cheloniidae. At this stage the plastron was conspicuous in that it had extended forward well beyond the level of the carapace, as a broad subquadrangular plate,[1] while the scales on the corselet were so tubercular as to impart to it a distinctly beaded appearance. The enlarged ridge scales which are subquadrangular in the newly hatched had begun to assume a polygonal shape ; especially the marginals. These were larger than those on the other ridges and each had a definite areolar area. The costal ridges were next in size and prominence. (Plate XIX).

RELATIONSHIP BETWEEN SCALES AND PLATELETS OF CORSELET

It is interesting to note that in one specimen, which died on November 17th, the scales from the top of the head and the greater part of the carapace sloughed off in large tracts exposing a smooth, slaty blue skin very similar to that of the smooth skinned adult only somewhat lighter. The longitudinal white carapace-bands did not reappear and the pigmentation was very different from that of the scales which peeled off. However, the scale divisions were still discernible on these areas. The nucho-scapular hump, neck, limbs and plastron, still retained their scales. The animal died on November 17th, probably due to foul water, when its measurements were found to be unaltered.

1. In preserved specimens the plastron shrinks until it is leve with the carapace.

The manner in which the scale boundaries disappear is unknown. There are two possible methods. The desquamation induced by fresh water as well as by foul sea water on the 38-day Bentota specimen may be an acceleration of what normally occurs and the scales may be shed never to reappear. On the other hand, the persistence of scale divisions on the smooth naked skin thus exposed in the turtlet and the presence of areolar areas on the enlarged scales in the corselet of Dermochelys which are homologous with those on the scutes of Thecophora suggests that they thin out and expand until they are indistinguishable. Such a process occurs in several Thecophora and is well illustrated on the gluteal and femoral areas of the Cheloniidae. (Deraniyagala, 1930*a*).

The corselet pores furnish further proof. Each is surrounded by four or five scales in the young, but in the adult each pore has four or five grooves radiating outward which are apparently vestiges of the scale divisions. The pores themselves are of importance in solving the problem of platelet formation. Pores have been found in four positions and appear in pairs. The most constant of these is located at the origin of the marginal ridge, midway between this and the supramarginal ridge is another, while the third lies a snout length behind the neck immediately under the marginal ridge and the fourth which is on the inframarginal ridge is also a snout length behind the neck. Each is surrounded by four or five scales in the young and all are located behind the anterior margin of the carapace (Plates XIX, XX, fig. 2). Hence if platelets arise from corselet scales, in the adult these pores should be surrounded by platelets as they once were with scales. But dissection of two large females shows that there are no such platelets. Actual measurements illustrate this better. Length of carapace along curve of neural ridge 1,590 mm., distance between crests of marginal and supra-marginal ridges 190 mm., distance from skin of neck to marginal pore 33 mm., to supramarginal pore 17 mm., distance from carapace platelets to marginal pore 15 mm., to supramarginal pore 33 mm.

It is now definitely seen that platelets do not form under these anterior scales, although they form a complete shell over the remainder of the carapace. In addition it is noticed that although lepidosis is as distinct on the plastron as on the carapace the plastral platelets are confined to the ridges only and are vestigial or even completely absent. If the platelets are ossified scales they should either be as numerous on the plastron as on the carapace or the plastral lepidosis should be vestigial or absent in proportion to its future platelet development. Neither of these is the case. Further there are several points of difference between the carapace lepidosis of the young and the platelets of the adult.

In young Dermochelys the enlarged ridge scales are subequal, uniserial, and subquadrangular, later becoming polygonal. Each scale is rather less than twice the size of the small polygonal scales which lie in four or five longitudinal rows between ridge and ridge. In the smooth skinned adult each ridge is broken up into a series of prominences. These are caused by the carinations of enlarged uniserial platelets which are irregularly polygonal and ten to twelve times as large as the others. Between every two or three of these large ridge platelets lie one or two small flat platelets. The infantile lepidosis shows no such intervening small ridge scales. In the adult the flat platelets on the interspaces instead of being reduced as a result of the expansion of the ridge platelets have increased numerically and are in ten to thirteen longitudinal rows.

These adult platelets can only be derived from the infantile lepidosis if the latter underwent a marked numerical increase and change of shape. But the constancy of the lepidosis in embryos and in the 38 and 62-day specimens does not support this view.

Unfortunately no ossification could be traced in the corselet of the 62-day specimen which was treated with alizarin. Had platelets been present, even as rudiments, it would have been easy to note their position with regard to the external scale boundaries.

The fact that the carapace ridges, which are covered with enlarged scales in the young consist of enlarged platelets, in the adult shows that in the Atheca the scales control their platelet dimensions in a manner resembling the restriction of Thecophoran plates by their external scutes.

The following dimensions of a section of carapace from the female Dermochelys previously mentioned show several features, wherein the Athecan carapace differs from the Thecophoran. Total thickness of carapace section 41 mm. This consisted of a dermal carapace 36 mm. thick upon which lay the platelets and thin outer cuticle which together were 5 mm. thick. It will be seen that the platelets are directly under the outer cuticle and lie superficially upon the dermal carapace which is unaltered. The plates of the Thecophora, on the other hand, originate deep down in the infantile dermal carapace which is more or less completely replaced by these ossifications.

Hence it is probable that the connection between the scales and platelets of the Atheca is closer than that between the scutes and plates of the Thecophora, and that the Athecan carapace is the more primitive of the two, for in it the dermal carapace is not replaced by secondary growths of bone. (Deraniyagala, 1930*a*).

GROWTH CHANGES

The evidence examined shows that the smooth skinned condition in Dermochelys results from the thinning out of the infantile scales which are not directly responsible for the corselet platelets. Six striking changes occur from infantile to adult age. The scale boundaries and claws disappear, a conspicuous cruro-caudal fold develops as do the corselet platelets which appear to be the last major structures to ossify, the plastron projects anteriorly beyond the level of the carapace margin and later is again overlapped by the carapace.

Nothing is known of the development and growth of this remarkable turtle. The adolescent stage, which appears to be spent far from land, is unknown and the newly hatched young reared in captivity sickened and died on a diet of fish, the longest period that such a specimen lived being sixty-two days. The changes noted in this and in more short-lived specimens were as follows :—

The white carapace bands and flipper margins became more distinct, and conspicuous white spots showed at the bases of the limbs. The plastron projected anteriorly, well beyond the level of the carapace, but in spirits specimens shrank back to its former level. The carapace became rounded in marginal outline, while its supracaudal portion was sharply constricted. The body became markedly depressed, but this condition may have resulted from ill-health. The corselet scales spread out, and the rows of enlarged ones altered in outline from quadrangular to polygonal, and developed boss-like areolar areas. The gular scales became smaller and more granular proportionately. In one instance claws appeared at the tips of the first and second digits and in several other cases pits were formed instead by the excrescence of two large scales. In the adult the scale boundaries disappeared except for what are possibly faint vestiges on the lower eyelid, neck and tail. The fore limb is shorter than the carapace and has an acute tip. All the limbs are now clawless and a strong cruro-caudal fold connects the entire posterior margin of each hind limb with the base of the compressed tail (Plate XX, fig. 4). The nucho-scapular hump is well developed and as high or higher than the rest of the body. The supracaudal part of the carapace is elongate. The body loses its depressed shape and is more cylindrical.

Both sexes are coloured alike. Dorsally slaty blue with numerous pale blue spots, ventrally white reticulate with black. The white carapace bands hitherto constant from the embryo to the young stages have disappeared completely and numerous bluish white spots appear on the interspaces between the ridges. Dorsally the infantile white

pigmentation persists on the head, neck and caudal crest. The throat and under surfaces of the flippers are white reticulate with black or brown, but the flippers no longer have the infantile white margins. The plastral ridges are white, the dark pigment on the interspaces is much reduced and sometimes even absent except marginally.

The adult male has a rather depressed profile, a concave plastron, narrow hips and a tail which reaches considerably beyond the hind limbs when these are placed edge to edge. (See Babcock, 1919, Plate 17, fig. 2). The female has a convex or straight profile,[1] a convex plastron, wide hips and the tail is shorter than the hind limbs, while the body depth is proportionately greater than in the male. The dimensions of a normal male were: Total length 2,060 mm., head 300 mm., length of carapace 1,520 mm., width of carapace 750 mm., axilla to groin 620 mm., tip to tip of spread fore limbs 2,730 mm., plastron to tip of tail 590 mm. A normal female was: Total length 1,875 mm., head 280 mm., length of carapace 1,475 mm., width of carapace 680 mm., axilla to groin 520 mm., tip to tip of spread fore limbs 2,937 mm., fore limb to wrist 880 mm., plastron to tip of tail 445 mm., weight 301·63 kilogms. (See Appendix).

SUMMARY

10-day embryo 5·5 mm. long, 12 anterior somites to behind fore limbs, 12 more to base of tail. Open ventrally. Chorioid fissure and ectodermal branchial grooves present, tail bent upwards. Plate XII, fig. 1.

13-day embryo 7·5 mm. long, somites as before, better definition. Visceral arches with branchial nodes. Tail curved downwards, allantois trilobed. Plate XII, figs. 2, 3.

15-day embryo 9·5 mm. long, somites as before, anterior ones reduced, branchial grooves disappearing. Plate XIII, fig. 2.

21-day embryo 12·5 mm. long, somites as before. Body closed ventrally, eyes pigmented, chorioid fissure closed, visceral grooves gone. Limbs with end plates. Carapace begins as a lateral ridge and ends as a bump above hind limb. Features of order Testudinata begin. Plate XIV.

24-day embryo 13 mm. long. Oro-nasal groove closed, premaxillo-maxillary cusps appear. White pigment on corselet ridges, tissues differentiate out from mesoderm. Family characters begin. Plate XV, fig. 1.

1. The adult female figured by Deraniyagala 1930 (a) on Plate VIII is represented with the head of a male.

26-day embryo 14 mm. long. Black pigment on carapace which is confluent with neck and tail, supracaudal crest begins. Eyelid begins, rostral point present. Plate XV, fig. 2.

27-day embryo 31 mm. long. Lepidosis begins. Ectodermal placode-like thickenings of sclerotic plates, ear subdermal, nuchal and plastral bones ossify. Family characters complete. Plate XVI, fig. 1.

48-day embryo 65 mm. long. Nucho-scapular hump appears. Oral papillae present. A complete ring of sclerotic bones on eye ball. Lepidosis and colour complete. Ribs ossified from vertebrae to under costal ridges. External generic characters nearly complete.

58 to 65 days.[1] Embryos 82 to 85 mm. long and ready to hatch. Fore flipper as long as carapace, outline of tip rounded. Rudiments of claws at times present on first and second digits. Ossification almost as complete as in adult. The ring of sclerotic bones is usually open antero-dorsally. Nucho-scapular hump at a lower level than middle of carapace. Anterior margins of carapce and plastron level, corselet compressed. Nearly all external specific characters present.

17 days after hatching. Length 98 mm. Claws if present as rudiments, become fully developed. Corselet scales show areolae. Plastron extends anteriorly beyond the carapace. No osseous platelets in corselet which is strongly depressed and has a rounded outline. Plate XIX.

Age and length unknown. Corselet platelets begin to ossify. Scale boundaries and claws disappear. A strong dermal fold develops between each hind limb and tail (Plate XX, fig. 4). Bands of white on carapace disappear ; white spots appear on interspaces.

Adult. Length 1,800 mm. to 2,000 mm., covered in smooth skin. Fore limb, with an acute tip, shorter than carapace. Carapace platelets completely ossified and sutured together, plastron with or without a few rows of vestigial platelets. Nucho-scapular hump as high or higher than rest of carapace. The ring of sclerotic bones closed and sutured together. Secondary sexual characters present. Plastral bones the same as when a few days old. Dorsally white pigmentation of head, neck and caudal crest same as in embryos. Body shape alters from depressed to subcylindrical.

On considering these various morphological changes it would appear that Dermochelys displays a closer approach to the larval stages of the Amphibia than any other living reptile. Apart from this feature, several of its adult characters such as the clawless limbs, smooth skin, crested tail, the palaeorbital skull with its intertrabe-

1. See Deraniyagala, 1930 (*a*), Plate VII.

cula, temporal roofing, enlarged parasphenoid, the position of the choanae under the nares, the absence of an entoplastral element, the general appearance of the pelvis and the cartilaginous nature of the skeleton are curiously reminiscent of the class mentioned.

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EXPLANATION OF PLATES

PLATE XII

21-day embryos

Fig. 1. Embryo A. Fig. 2. Embryo B. Fig. 3. Allantois of B, ventral view.

a.=allantois, bn.=branchial node, e.=eye, f.=fore limb, h.=heart, lp.=left hind limb, o.=ear.

PLATE XIII

21-day embryos

Fig. 1. Embryo C. of 1930. Fig. 2. Embryo D. of 1929

a.=allantois, ap.=auricular process, ba.=branchial arch, bn.=branchial nodes, f.=fore limb, h.=heart, lp.=left hind limb, n.=olfactory opening, o.=ear, t.=tail.

PLATE XIV

21-day embryo E.

a.=allantois, cv.=precervical sulcus.

PLATE XV

Fig. 1. 24-day embryo F. Fig. 2. 26-day embryo G.

ap.=auricular process, c.=columella auris, i.=iliac protuberance, lp.=left hind limb m.=margin of carapace, n.=nostril, r.=rostral point, s.=shoulder plate.

PLATE XVI

Fig. 1. 27-day embryo H. Fig. 2. twin embryos

n.=nostril, pm.=premaxillo-maxillary cusp, r.=rostral point, so.=supra occipital scales.

PLATE XVII

Cephalic membrane bones of embryo H.
Fig. 1. Ventral view of palate.
Fig. 2. Dorsal view of head.
Fig. 3. Lateral view of head.

f.=frontal, j.=jugal, m.=maxillary, pal.=palatine, par.=parietal, pf.=postfrontal, pm.=premaxillary, prf.=prefrontal, psp.=parasphenoid, pt.=pterygoid, pv.=prevomer, sq.=squamosal, qj.=quadrato-jugal.

Plate XVIII

Ossification of sclerotic ring.
Fig. 1. Sclerotic ring of embryo IV.
Fig. 2. Closed ring of mature embryo.
Fig. 3. Open ring of mature embryo.
Fig. 4. Eye of adult female.
Arrow denotes antero-dorsal area.

Plate XIX

Young Dermochelys (20 days). Note carapace pores, marginal areolar areas and plastron.

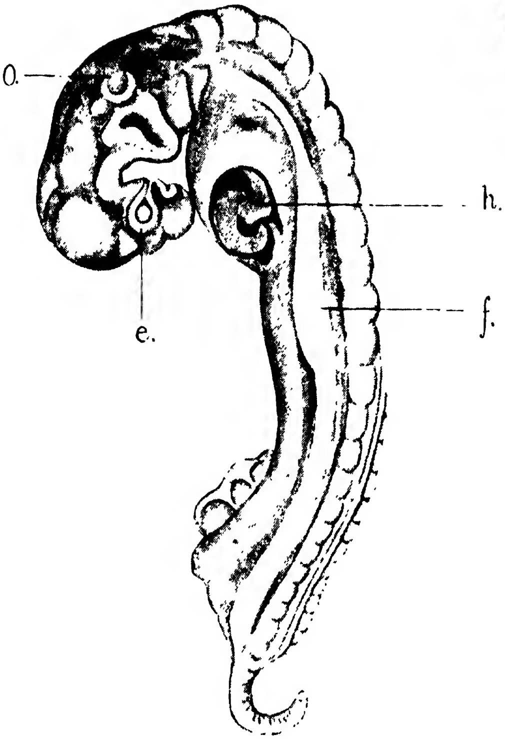
Plate XX

Fig. 1. Caudal kink of Vadduva young (lateral). Caudal crest folded over on to the right side.
Fig. 2. Carapace pores of young (lateral).
Fig. 3. Cruro-caudal fold of young (ventral).
Fig. 4. Cruro-caudal fold of adult female (ventral)
Lepidosis omitted from figs. 1, 2, 3.

Appendix

Measurements of Dermochelys at different ages

Specimen.	Age.	L of C	W of C.	L of P.	L of Head.	Axilla to groin.
		mm.	mm.	mm.	mm.	mm.
(1) Born September 3, 1929, at Kalutara.	Just hatched.	58	36	46	24	28
	17 days on September 19	67	39	52·5	25	30
(2) Born September 3, 1929, at Kalutara.	Just hatched	60	36	46	24	28
(3) Born October 10, 1931, at Bentota	17 days on October 27	71	49	61	36	25
(4) Born October 10, 1931, at Bentota	17 days on October 27	71	49	63	36	25
(5) Born February 27, 1932, at Bentota	5 days on March 2.	65	45	55	27	31
	62 days on April 28	82	56	71	27·5	45
(6) Born March 9, 1932, at Vadduva	March 9	58	37	45	27	
	37 days on April 15	75	51	60	25	41
(7) Adult female, Kalutara	May 14, 1929	1475	680	1090	280	520
(8) Adult female, Colombo	February 24, 1932	1590	1190	—	275	790
(9) Adult male netted off Colombo	June 11, 1930	1520	1140	1140	300	620



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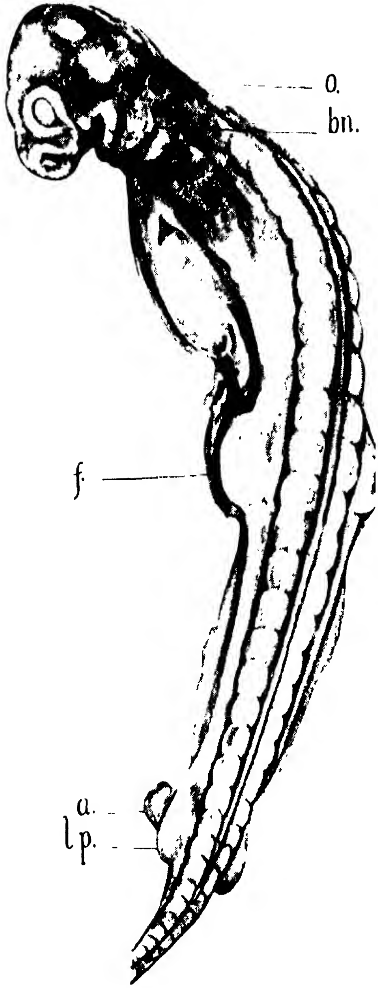
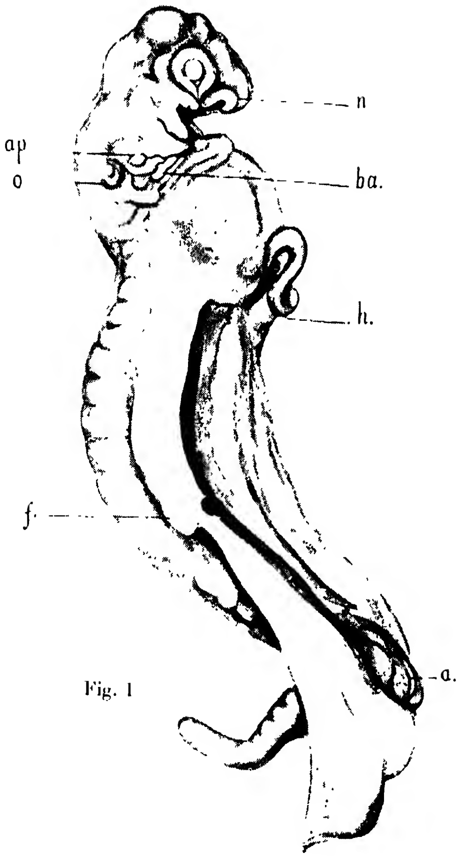


Fig. 2

Fig. 3

P.E.P.D. del.

Development of *Dermochelys*



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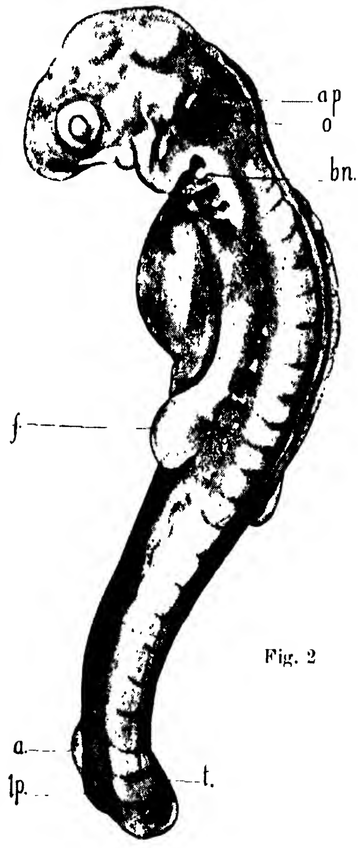


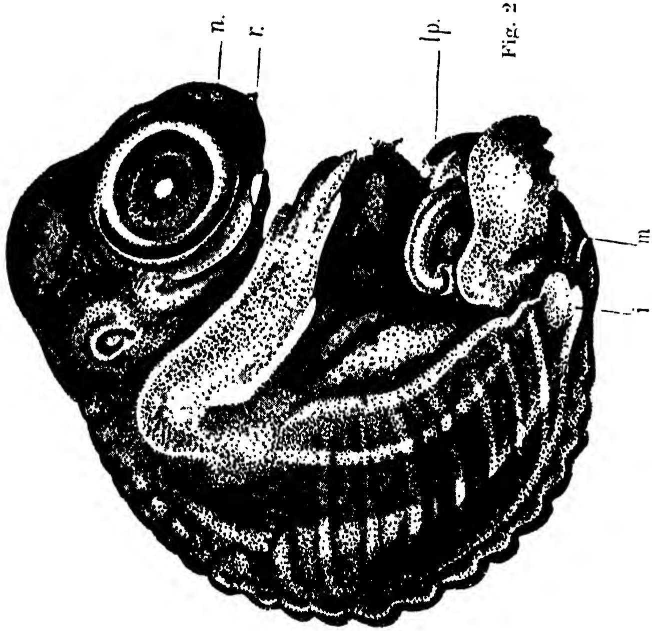
Fig. 2

P.E.P.D. del.

Development of *Dermochelys*

P.E.P D. del.

Development of *Dermochelys*



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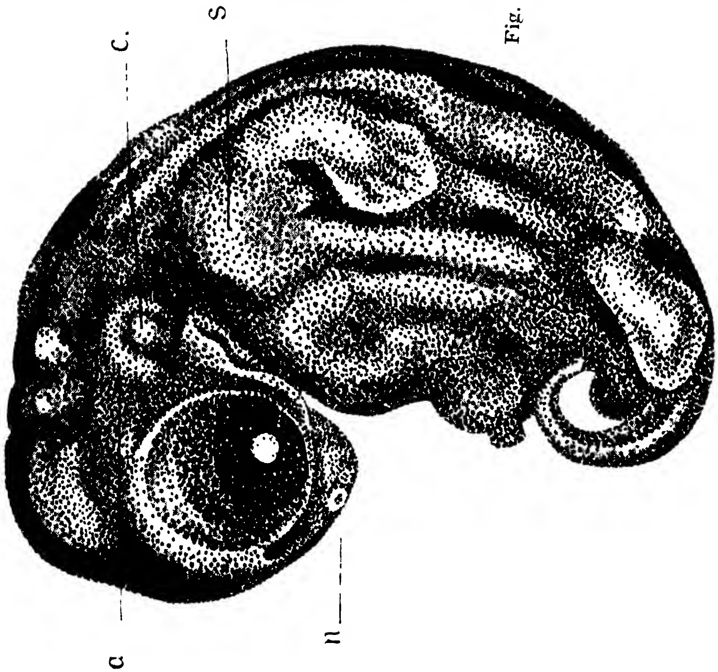


Fig.

E.P.D.

Development of *Dermochelys*

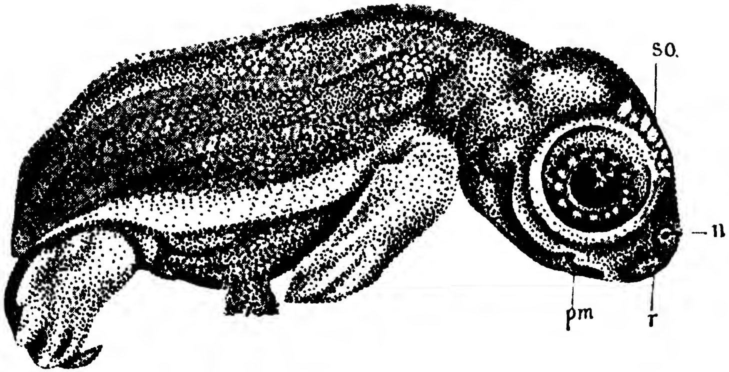


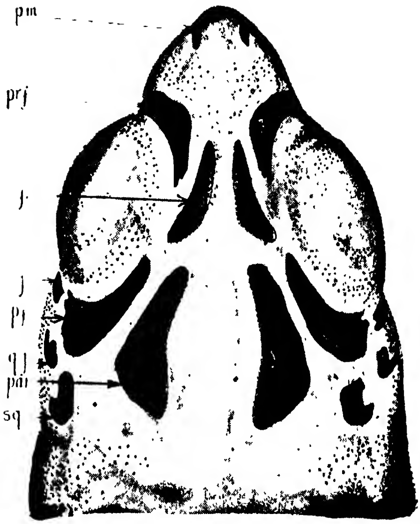
Fig. 1

Fig. 2

P.E.P.D. del.

Development of *Dermochelys*

Fig. 1



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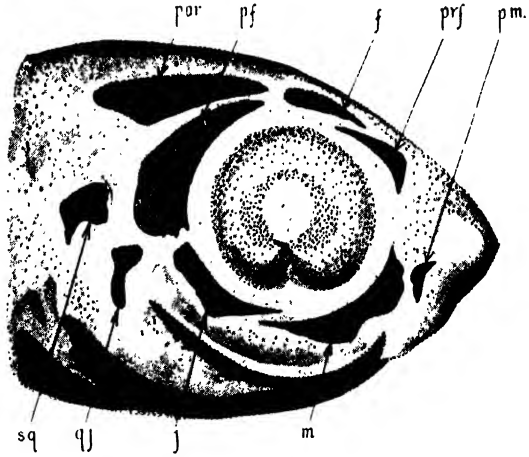
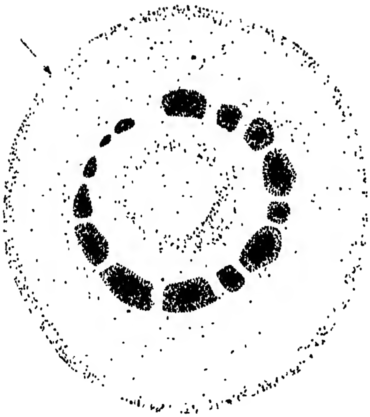


Fig. 3

P.E.P. D. del.

Development of *Dermochelys*



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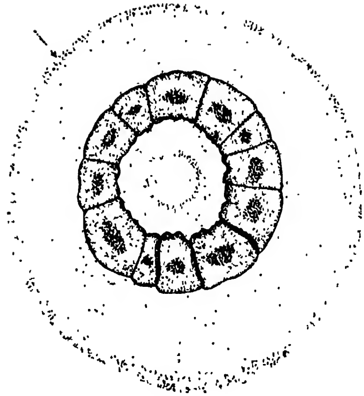

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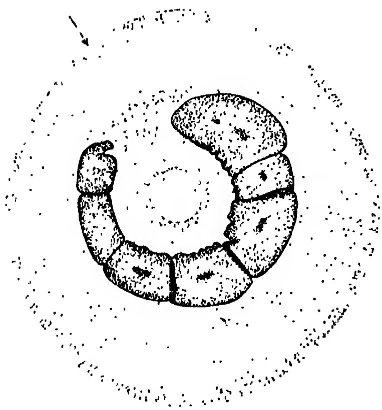

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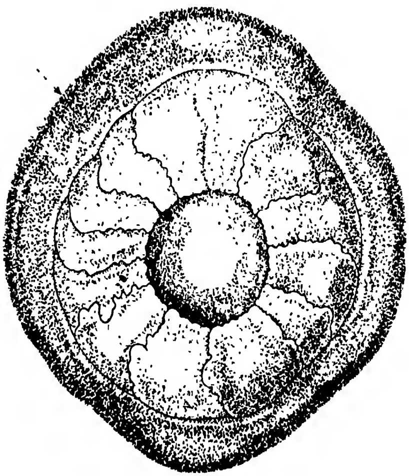

Fig. 4

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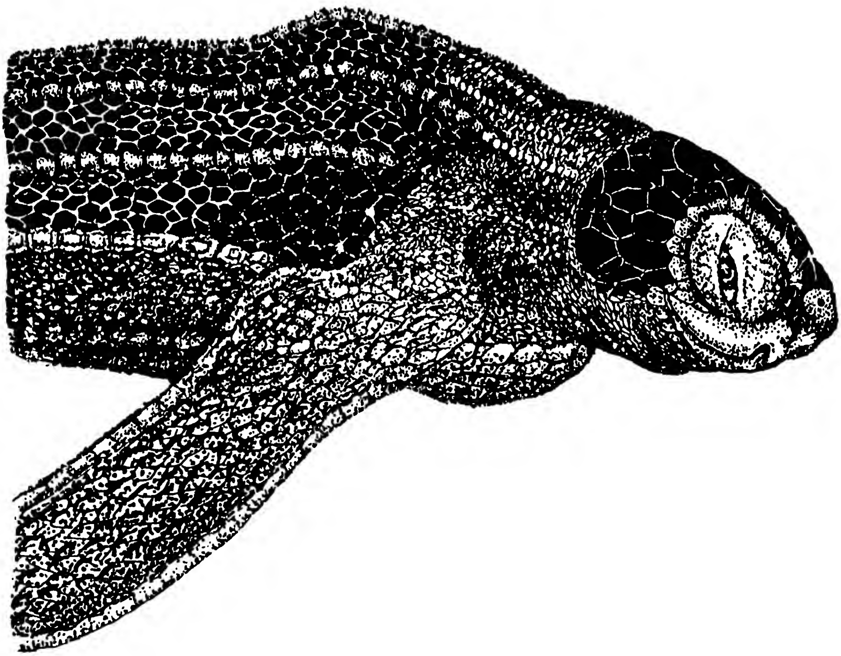
Development of *Dermochelys*



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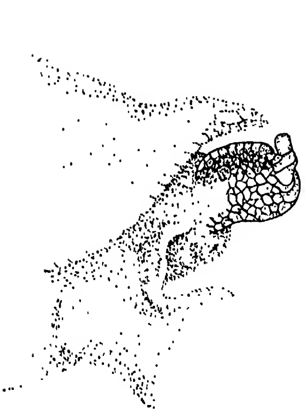
Development of *Dermochelys*



g. 1

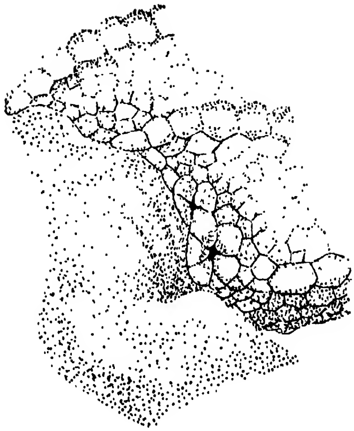


Fig. 2

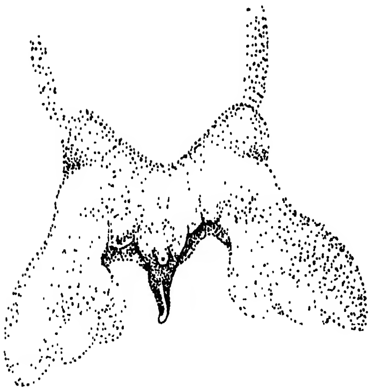


Fig. 3

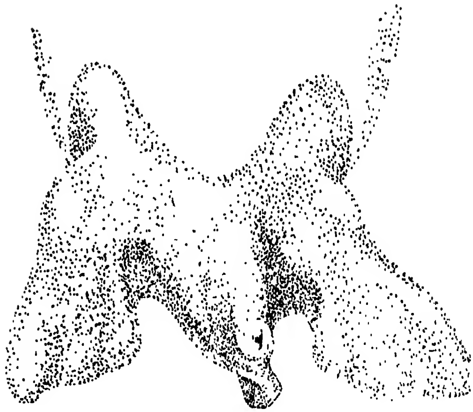


Fig. 4

P.E.P.D. del.

Development of *Dermochelys*

Notes on the course of the Lateral Line Canals and the Cranial Nerves in the Viviparous Shark Scoliodon (Carcharias)

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(With Four Plates)

Although the cranial nerves and the lateral line canal system in Selachii have been extensively studied it has become necessary to obtain a detailed description of these structures in Scoliodon which is now being increasingly used as a laboratory type in the colleges of India and Ceylon. Very recently Thilliampalam[1] has described the anatomy of Scoliodon, but her account of the cranial nerves does not, in my opinion, afford an altogether adequate guide to the student. The present description is therefore an attempt at a more complete understanding of these structures in Scoliodon.

The Lateral Line Canals

The main lateral line canal of each side of the trunk runs forward to the head where it is continued to a short distance behind the orbit. In the occipital region the canals of the two sides are connected together by a transverse *occipital commissure* which lies just posterior to the external openings of the endolymphatic ducts. On approaching the orbit each canal divides into a *supra-orbital canal* running above the orbit and an *infra-orbital* running below. The supra-orbital canal itself soon divides into two ; one branch loops towards the dorsal middle of the head and then runs to the tip of the snout where it bends sharply backwards and continues along the ventro-lateral edge of the snout to a little distance behind the naris ; the other branch meets the infra-orbital canal in front of the orbit. From this point the infra-orbital canal curves ventrally to meet the extension of the first branch of the

1. Thilliampalam. *The Indian Zoological Memoirs* II. Scoliodon, Lucknow, 1928.

supra-orbital canal behind the naris and then runs transversely to join its fellow of the opposite side in the mid-ventral line. The fused infra-orbital canals run forward a short distance along the mid-ventral line but separate again to join the angle formed by the supra-orbital canal at the tip of the snout.

Starting from in front of the first gill-slit a canal—*the jugal canal*—extends across the cheek and is continued forward close to the infra-orbital canal with which it joins behind the naris. A short branch from the infra-orbital canal behind the orbit connects with the jugal, and a *mandibular canal* lying below the lower jaw may join the jugal (in *S. sorrakowah*) or may remain separated from it by a short distance (in *S. walbheemi*).

Thilliampalam describes the mandibular canal of *S. sorrakowah* as being connected with what that author terms the hyoidean canal. This should more correctly be termed the *jugal* canal since it is supplied by a special branch of the hyomandibularis nerve and runs forward between the mouth and the orbit to join the infra-orbital canal behind the naris. The hyomandibular part of the canal appears to be suppressed, its function probably being transferred to the group of ampullae of Lorenzini situated in that region.

That part of the canal between the point where the transverse occipital is given off and its division into supra- and infra-orbitals is innervated completely by the otic branch of the Facial nerve and should therefore be termed the *post-orbital*. In Osteichthyes generally there is a posterior division of it into a temporal canal supplied by the supra-temporal branch of the Glossopharyngeal, but this is unrepresented in Selachians.

The Cranial Nerves

The nerves which arise from the brain and come out through foramina in the cranium are known as cranial nerves. Including the Terminal nerves there are eleven such pairs of cranial nerves in Scoliodon.

The olfactory tract which is merely a prolongation of the antero-lateral wall of the cerebrum on each side ends in a bilobed swelling. These olfactory bulbs lie in a line with the anterior limit of the cerebrum and are closely apposed to the nasal sac into the epithelium of which a number of nerve fibres—the *Olfactory* nerves—extend from the bulbs. The Olfactory nerves belong to the visceral sensory system.

A pair of delicate *Terminal* nerves come out through the recessus neuroporicus on the ventral floor of the cerebrum. Each of these nerves

bears a ganglion a short distance from its origin and runs forward below the cerebrum. It then crosses over the inner olfactory bulb of its side to join the outer bulb (Plate XXI). It consists of general cutaneous fibres distributed to the nasal septum and external nostril.

The *Optic* nerves are a pair of stout sensory nerves which convey visual impulses from the retina of the eyes to the brain. The fibres of these nerves cross each other on the floor of the diencephalon to form an optic chiasma and terminate in the optic lobes where their nerve centres are situated.

The Occulomotor, the Trochlearis (or Patheticus), and the Abducens are all somatic motor nerves supplying the eye muscles. They are formed in ontogeny as the ventral-root nerves of the segments of the head from which these muscles are derived. Their corresponding dorsal roots are the Ophthalmicus profundus, the Trigeminal (in part), and the Facial nerves.

The *Occulomotor* nerve arises from the floor of the mesencephalon. It pierces the side-wall of the cranium and enters the orbit where it branches to supply the anterior rectus muscle; it then sends a branch to the superior rectus muscle and runs through that muscle close to its base, curves behind the inferior rectus muscle sending a small branch to it, and finally runs along the ventral floor of the orbit to end on the inferior oblique muscle (fig. 3).

The *Trochlear* nerve arises from the dorso-lateral wall of the mesencephalon behind the optic lobe. It runs a little way within the cranial cavity above the optic lobe before it enters the orbit rather dorsally and innervates the superior oblique muscle.

The *Abducens* nerve arises ventrally from the medulla oblongata and supplies the posterior rectus muscle.

The Ophthalmicus profundus, the Trigeminal, and the Facial nerves arise very close together from the antero-lateral angle of the medulla oblongata.

The *Ophthalmicus profundus* is composed entirely of general cutaneous fibres which are distributed in the skin of the region of the snout. It enters the orbit through a foramen in close proximity with that of the Occulomotor nerve and even pierces through the superior rectus along with the latter nerve. It then runs forward in the orbit below the anterior rectus and above the Optic nerve and oblique muscles to travel through the olfactory capsule on its way to the snout (Plate XXII, figs. 1 and 2). The Profundus is often described as a branch of the Trigeminal nerve, but it should be borne in mind that this association of the Profundus with the Trigeminal is only secondary.

The *Trigeminal* nerve has three branches :—(1) A ramus ophthalmicus superficialis of general cutaneous fibres, (2) a ramus maxillaris also of general cutaneous fibres, and (3) a ramus mandibularis of visceral motor fibres. The ramus ophthalmicus superficialis joins a similarly named branch from the Facialis to issue out of the cranium by a common foramen and run above the orbit to the snout. The fibres of the ramus maxillaris are in two groups. One of these travels with the buccalis branch of the Facialis to supply the anterior region of the upper lip, while the other runs alongside the ramus mandibularis and supplies the more posterior part of the upper lip. The ramus mandibularis runs out along the posterior edge of the orbit and curves round the angle of the mouth to supply the lower jaw muscles.

The *Facialis* is a large nerve of mixed components. Its fibres come out of the cranium in two bundles. One of these is composed only of acustico-lateralis fibres and forms the ophthalmicus superficialis branch which comes out of the cranium along with the ophthalmicus superficialis branch of the Trigeminal. These fibres are distributed to the supra-orbital canal and the ampullary organs of the snout. The other bundle of mixed fibres comes through the cranial wall along with the maxillary and mandibular branches of the Trigeminal and divides into :—(1) A ramus buccalis, (2) a ramus hyomandibularis, and (3) a ramus palatinus. The buccalis is a broad flat nerve of acustico-lateralis fibres running diagonally across the floor of the orbit to supply the infra-orbital canal and the more ventral ampullary organs of the snout. Buccalis fibres running separately from this nerve supply that part of the infra-orbital canal immediately behind and below the orbit. The ramus hyomandibularis runs backwards and outwards along the anterior face of the otic capsule and comes to the surface, lying underneath the skin of the cheek. It gives off a slender otic branch of acustico-lateralis fibres which runs upwards to supply the post-orbital canal. Soon after this again a branch from it proceeds anteriorly between the upper jaw and the orbit to innervate the jugal canal, and another branch—the oral—runs to the lower lip. Both these branches are composed of acustico-lateralis fibres. The main hyomandibular nerve continues a little way further backwards and downwards until it forks out into three branches :—(*a*) A mandibularis externus branch of acustico-lateralis fibres to the mandibular canal; (*b*) a mandibularis internus branch of visceral sensory fibres to the floor of the buccal cavity, and (*c*) a hyoidean branch of visceral motor fibres to the muscles of the hyoid arch. The ramus palatinus lies in the orbit below the mandibular branch of the Trigeminal. Its main branch runs a little way forwards and then enters the roof of the mouth, while a few small

branches run posteriorly to the dorsal wall of the pharynx. The palatinus is composed of visceral sensory fibres.

The *Auditory* nerve enters the auditory capsule to supply the membranous labyrinth of the ear. It is to be regarded as a portion of the acustico-lateral system.

The *Glossopharyngeal* nerve arises more posteriorly from the medulla oblongata. It runs below the auditory capsule and comes out of the cranium from its postero-lateral angle. Here it divides into a pre-trematic branch of visceral sensory fibres running in front of the first gill-slit and a post-trematic branch of mixed visceral sensory and visceral motor fibres behind it. It also gives off a slender branch of visceral sensory fibres to the pharynx.

The *Vagus* is a compound nerve formed by the coalescence of the dorsal roots of the last four meta-otic segments of the head region. It arises from the lateral wall of the medulla oblongata behind the Glosso-pharyngeal nerve and has a broad base. Its exit through the cranium is placed between the foramen magnum and the foramen for the Glosso-pharyngeal nerve. It divides into a lateralis branch, a visceralis branch, and four branchialis branches in relation to each of the last four gill-slits. The lateralis branch of acustico-lateralis fibres becomes separated anteriorly from the base of the main nerve and runs backwards through the muscles of the trunk parallel to the course of the lateral line canal. giving off on its way a number of small fibres which end in the neuro-mast organs of the lateral line canal (Plate XXIII). At its anterior end the lateralis branch gives off a small twig to the transverse occipital canal. The visceralis branch carrying both sensory and motor fibres enters the body cavity to be distributed to the heart, lungs, liver, and the alimentary canal. Each of the four branchialis branches is similar in composition to the Glossopharyngeal nerve, that is, each of them has a visceral sensory branch to the pharynx, a pre-trematic branch of visceral sensory fibres, and a post-trematic branch of visceral sensory and visceral motor fibres.

I have to thank Mr. D. R. R. Burt, Lecturer in Zoology, Ceylon University College, for some useful suggestions and also to acknowledge with gratitude the drawing of Plate XXI by Mr. P. E. P. Deraniyagala, Second Assistant Marine Biologist, Ceylon Fisheries Department.

EXPLANATION OF PLATES

Plate XXI

Fig 1. Brain of Scoliodon. Dorsal view.

Plate XXII

Fig. 1. Eye muscles and nerves of the right eye. Dorsal view.
Fig. 2. Muscles and nerves of the eye with the eyeball removed. Left eye.

Plate XXIII

Fig. 1. Brain and cranial nerves of *S. walbheemi* from a dorso-lateral view. Semi-diagrammatic.

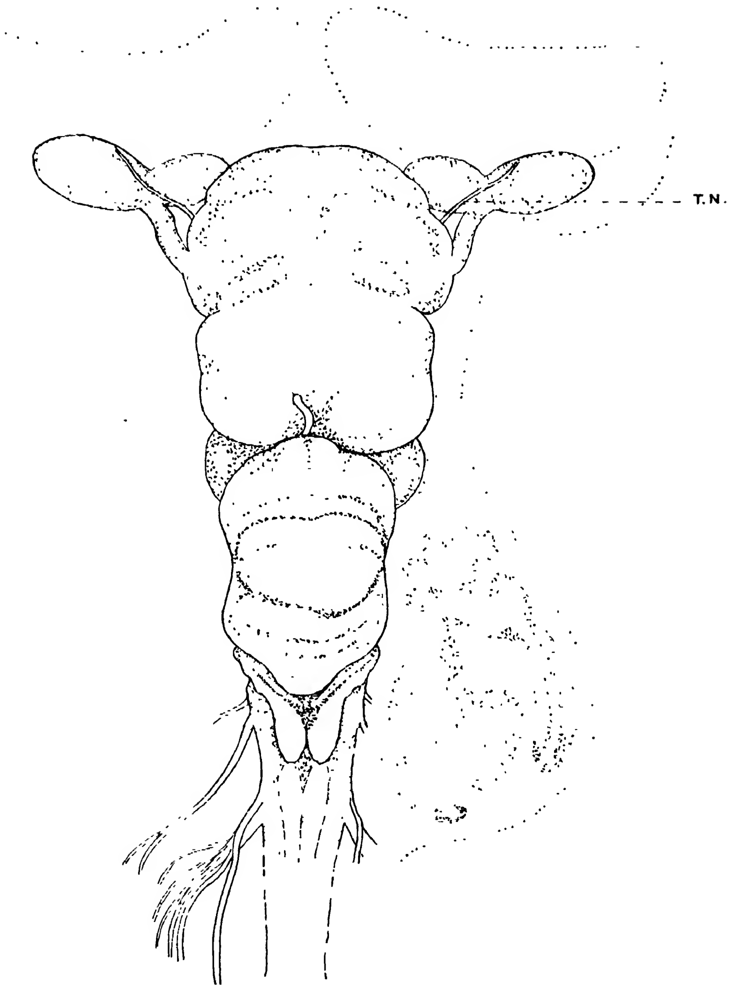
Plate XXIV

Fig. 1. Ventral view of head of *S. walbheemi*. The right side dissected to show the nerves.

Fig. 2. Dorsal view of head of *S. walbheemi* showing the sensory canals.

Reference Letters

Ab. N.	Abducens nerve.
Ant. R.	Anterior rectus.
Aud. N.	Auditory nerve.
Br. 1-4	Branchialis branches 1-4 of the vagus.
Buc.	Buccalis nerve.
Buc. Br.	Branch of buccalis nerve.
Buc. Ff.	Buccalis fibres.
Cb.	Cerebrum.
Cbl.	Cerebellum.
C. R.	Cartilage of rostrum.
Cr. W.	Cranial wall.
Gl. N.	Glossopharyngeal nerve.
G. S.	Gill slits.
Hy.	Hyoid nerve.
Hym. N.	Hyomandibular nerve.
Inf. Max. T.	Inferior maxillary of the Trigeminal.
Inf. Obl.	Inferior oblique.
Inf. Orb. Can.	Infra-orbital canal.
Inf. R.	Inferior rectus.
Jug.	Jugal.
Jug. Can.	Jugal canal.
Lat.	Lateralis branch of the vagus.
Lat. L. Can.	Lateral line canal.
Mn. Can.	Mandibular canal.
Mn. Ext.	Mandibularis externus.
Mn. Int.	Mandibularis internus
Mn. N. T.	Mandibular nerve of the Trigeminal.
M.O.	Medulla oblongata.
Nar.	Narial aperture.
Nas. Cap.	Nasal capsule.
N. M.	Nictitating membrane.
O. Com.	Occipital commissural canal.
Occ. N.	Occulomotor nerve.
O. D. End.	Opening of endolymphatic duct.
Olf. B.	Olfactory bulb.
Olf. Tr.	Olfactory tract.
Op. L.	Optic lobe.
Op N.	Optic nerve.
Op. P.	Optic pedicle.
Or.	Oral branch of the hyo-mandibular nerve.
Ot.	Otic branch of the hyo-mandibulor nerve.
Pal.	Palatine nerve.
Prf. N.	Profundus nerve.
P. S.	Pineal stalk.
Pt. Orb. Can.	Post-orbital canal.
Pt. R.	Posterior rectus.
R. B.	Restiform body.
Sp. C.	Spinal cord.
Sup. Max. T.	Superior maxillary of the Trigeminal.
Sup. Obl.	Superior oblique.
Sup. Oph. F.	Superficial ophthalmic of the Facial.
Sup. Oph. F. T.	Superficial ophthalmic of the Facial and the Trigeminal.
Sup. Orb. Can.	Supra-orbital canal.
Sup. R.	Superior rectus.
T. N.	Terminal nerve.
Tr. N.	Trochlearis nerve.
Visc.	Visceralis branch of the vagus.
V. N.	Vagus nerve.



Brain of *Scoliodon*

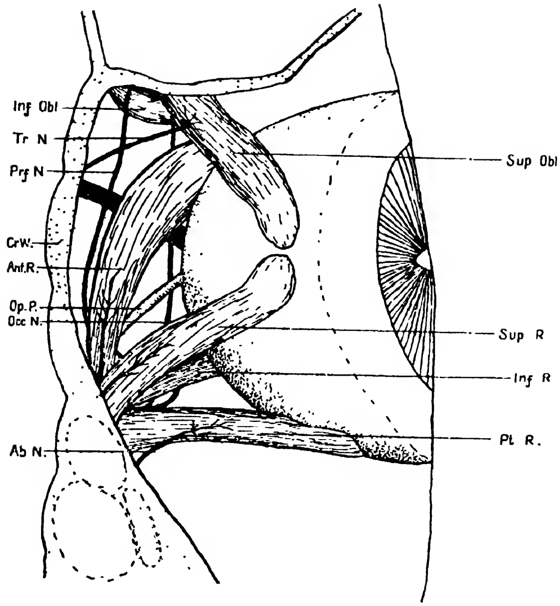


Fig. 1

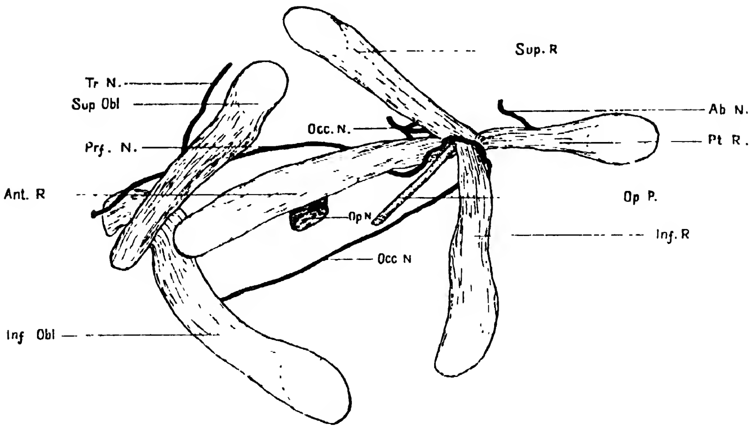
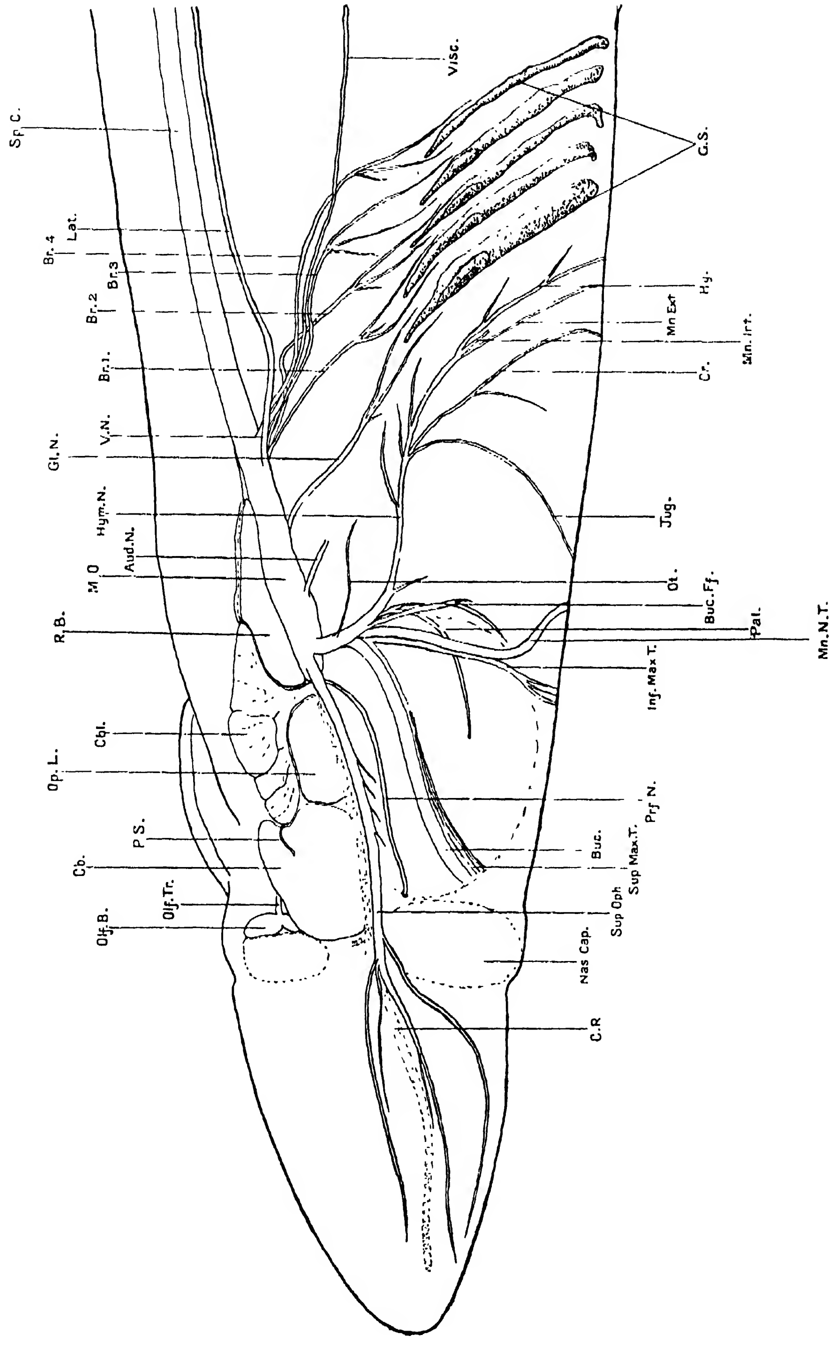


Fig 2

Eye-muscles and nerves of *Scoliodon*



Brain and cranial nerves of *Scoliodon*

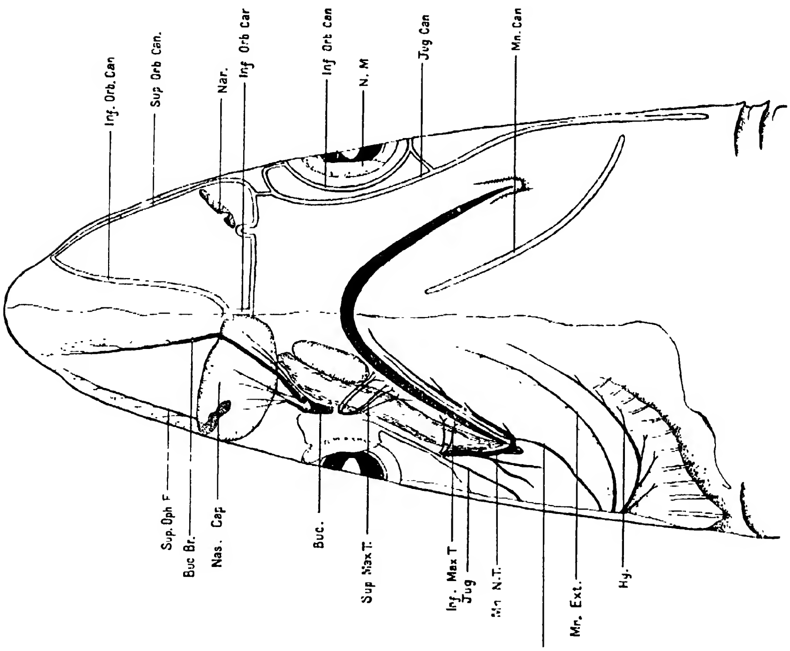


Fig. 1

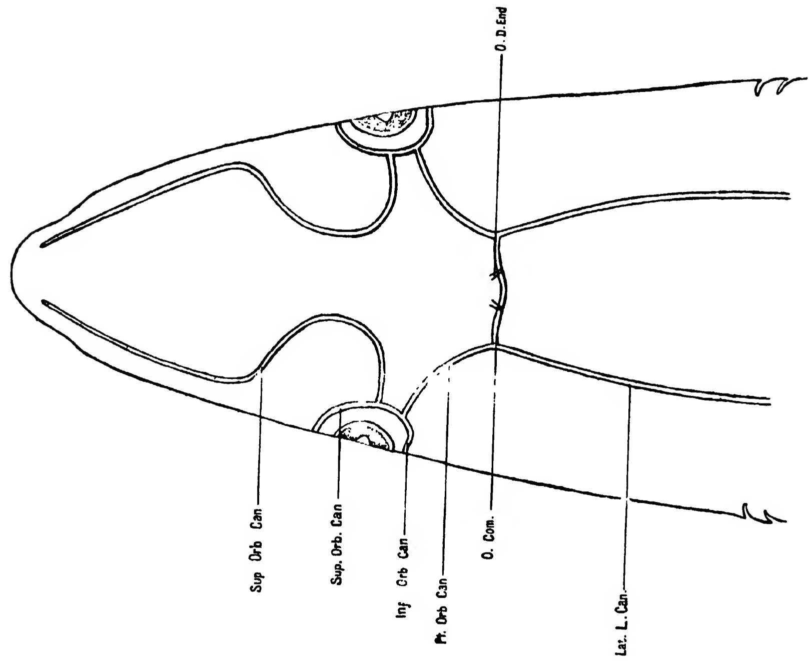


Fig. 2

Sensory canals of *Scoliodon*

A New Race of Slender Loris from the Highlands of Ceylon

BY

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AND

W. W. A. Phillips, F.Z.S.

(With Two Plates and One Text Figure)

In a small country like Ceylon, where the mammalian fauna has been rather extensively studied in recent years, it may seem surprising that, of all others, a new Primate should come to light. The Ceylon Slender Loris, *Loris tardigradus* (Linné) has long been known to have an extensive distribution in the Island, at any rate in the low-country. It has been recorded from most parts of the Island up to the 1,000-foot level or a little beyond, though never from heights approaching those recorded for its Indian neighbours, *L. lydekkerianus* and *L. malabaricus*. On consideration, however, it would not be unreasonable to expect that the Ceylon Loris, with so extensive a distribution, followed the lead of so many other Ceylon mammals by exhibiting minor racial variations in the different climatic zones of the Island. Hitherto, however, all the lorises from Ceylon that appear to have been at all thoroughly examined have come from within a radius of 30 or 40 miles of Colombo, and these all present the characteristic ruddy coat. As a matter of history, it is interesting to recall that Sir J. E. Tennent (1861) alludes to the presence of a black loris in Ceylon, in addition to the ordinary red form. He gave no description of this animal and reported that even the red loris was a comparative rarity, though he mentioned one specimen from Chilaw belonging to the usual red variety. Major T. C. Jerdon (1874) was aware of Tennent's statement and made the suggestion that the black loris was a Slow Loris (*Nycticebus*). There is no record in either Tennent or Jerdon as to where the black animal was likely to be found, and as far as we are aware no further mention has been made of this elusive animal.

Recently, however, we have collected lorises from altitudes of 2,000 feet and above, and these have been found to differ from the normal type in being more inclined to melanism and less to erythrism. We consider these recent specimens to form a well-marked local race, which we describe here as a new subspecies under the title, *Loris tardigradus grandis*, in allusion to the greater size and increased beauty of the new form over the typical lowland animal, which must henceforth be known as *L. t. tardigradus* (Linné). No specimens have as yet been recorded from altitudes intermediate between those known to be inhabited by *L. t. tardigradus* and those from which we have collected our specimens of *L. t. grandis*, but we have no doubt that when such specimens are discovered they will present intermediate characters, and that in these intermediate altitudes the two forms will grade into one another, in the way that subspecific forms generally do.

We are not at all certain that our new form is identical with Tennent's black loris. We rather suspect that Tennent's animal was a denizen of the northern dry zone. Since we instituted our first studies on the new highland animal, we have received information regarding the existence of a black loris in the North-Central Province. The villagers in that area recognise two forms living side by side, one red and one black. Whether their red form is the same as the typical race is uncertain. It may be a juvenile form of the black one, though this is doubtful. Again, whether this northern black form is the same as our new highland form is also uncertain. The only specimens we have examined are two in the collection of the Bombay Natural History Society collected for the Indian Mammal Survey by Major W. E. Mayor and labelled as typical specimens of Ceylon Slender Loris. They are apparently the only representatives of the Ceylon loris in that collection. These skins, however, are quite different from the typical red Ceylon loris, and undoubtedly represent a new form. But they also differ in certain particulars from our *L. t. grandis*, so that they possibly represent a third Ceylon loris. These questions cannot be satisfactorily settled with the material at present available.

Meanwhile, however, we consider it expedient to publish an account of the form we have named *L. t. grandis*, and, for the present, we limit the distribution of this form to the central hill zone of Ceylon. If the northern loris proves to be identical with it, we shall have to extend that range. On the other hand, if the northern black loris proves to be distinct, we shall later have to describe a new race and label it accordingly. In the interim we are collecting sufficient material for this purpose, and in a later paper we hope to revise the whole genus in the light of our further observations.

In passing, it is worth mentioning that this is not the first time that the typical Ceylon Slender Loris has been treated as a local race. R. Lydekker (1904) referred to the Ceylon animal as *L. gracilis ceylonensis*, the type of the species being labelled *L. g. typicus*, and the distribution given as South India. Lydekker's paper contained coloured figures of the faces of these two races but these figures are scarcely recognisable as slender lorises at all, by anyone acquainted with the living creatures. We trust that our own figures will correct some of the errors in Lydekker's figures. Lydekker may have been right in ranking the Indian and Ceylon animals as local variations of a single species, and our own researches at present tend to this opinion. But he was incorrect in taking the Indian form as the genotype. It was shown by Stone and Rehn (1902) and, more recently, by Oldfield Thomas (1908), that the Ceylon animal was the first to be described. The Indian animal, nowadays, goes under the name of *L. lydekkerianus* Cabr., whilst the Ceylon animal retains its Linnean title, *L. tardigradus.* Future work will probably necessitate the lowering of the status of the Indian forms to that of subspecies of *L. tardigradus.*

Loris tardigradus grandis, subsp. nov.

The Ceylon Highland Slender Loris

Size large ; larger than any loris previously recorded from Ceylon, though not as large as some Indian lorises.

General colour of upper parts blackish, with the tips of the hairs more or less frosted with silvery white, but always much more so than in *L. tardigradus tardigradus* ; lower parts generally pure white, or only slightly buffy ; throat always pure white ; facial markings always very contrasted and much more distinct than in the typical race ; the white interocular stripe bifurcating above and passing around the dark circum-ocular patch to form a pale band intervening between this and the dark pre-auricular hairs.

Fur longer and thicker than in *L. t. tardigradus*, the limbs especially being more heavily clothed.

The new race differs from the typical form in the following points :—(i) The larger size, (ii) the darker general colouration with less or no inclination to erythrism, (iii) the almost complete absence of colouration of the ventral surface, (iv) the contrasted facial markings, and (v) the different character of the fur. The limbs, in addition to being more heavily furred, are relatively longer and more muscular, giving a more powerful action.

The type specimen is an adult female from jungles near a tea estate at Mousakande, Gammaduwa, Central Province, Ceylon. She had been kept some time in captivity at Gammaduwa, and later for some months in Colombo. She was killed purposely so that a good type specimen should be available. The type skin, with skull, will be deposited in the British Museum (N.H.).

Two paratypes, with skulls, have been deposited in the Colombo Museum. These were both adult males. The skull of a third specimen, a very juvenile male, has also been added to the Colombo Museum collection.

Other material examined consists of living specimens of both sexes, adult and immature. These have all been in captivity for many months now, and still appear to be thriving well. They were kept at first by one of us (W. W. A. P.) at their native altitude, but for some time now they have been in the private collection of the other (W. C. O. H.) in Colombo. They seem quite healthy, and do not appear to have undergone any morphological change during their sojourn in the low-country. They are kept alongside a number of typical lowland lorises with whom they agree quite well. They all sleep together in a bunch, but the specimens of *L. t. grandis* can always be picked out, even by the uninitiated.

The total number of animals obtained and examined up to the moment is nine—five males and four females. Female lorises generally turn up less frequently than males, but our specimens of *grandis* show a much larger proportion of females to males than usual. All our specimens were fully adult, except two. Of these two both were males, one being half-grown, and the other about three-quarters grown. One of the females (still living) is probably the largest Ceylon loris on record. The other females are all larger than their mates. All the specimens were collected at or near the type locality mentioned above. All are of a darker shade than the typical Ceylon loris, but one or two incline to fulvous in parts. But coat-colour alone is never a good guide to identification, except when taken in conjunction with other morphic characteristics.

Size: It has already been mentioned that *L. t. grandis* differs primarily from the typical Ceylon Loris in its greater general size. This increase in size affects all parts of the animal's organisation. The increase is an example of the general rule followed among many Ceylon mammals, *i.e.*, that the highland races tend to be larger in size than their lowland relatives, as instanced by the Bear Monkey (*Pithecus senex monticola*), which is so much larger than its lowland counterpart, the Purple-faced Langur (*P. s. nestor*). This difference in size is hardly

so marked in the case of the two lorises but, nevertheless, it is a well-marked characteristic, striking the most casual observer.

The following measurements, from a series of specimens of both races, serve to illustrate the degree of difference in size between them :—

(*a*) ***Measurements of L. t. grandis***

No.	*Sex*	*Head and Body* mm.	*Hind foot* mm.	*Ear* mm.	*Remarks*
L. 1	♂ (juv.)	178	41	24	Altitude 2,000 ft.
L. 2	♂	209	44	26	„ 3,300 „
L. 3	♂	220	45	25	Paratype
L. 4	♂	200	47	22	
L. 5	♀	256·3	38	30	Still living
L. 6	♀	220	45	24	„
L. 7	♂ (subad)	185	42	24	„
L. 8	♀	217	47	26	Type specimen
L. 9	♀	198	45	23	Still living
Average of the 4 adult ♂♂		209·6	44·5	24·25	
Average of the 4 adult ♀♀		222·3	44·75	25·75	

(*b*) ***Measurements of L. t. tardigradus***

	mm.	mm.	mm.	
Av. of 9 ♂♂	183·4	38·2	21	Alt. below 900 ft.
Av. of 4 ♀♀	196·2	43	19·75	

Combining the two sexes from these two groups of measurements, we arrive at the following comparison :—

	L.t. grandis mm.	*L.t. tardigradus* mm.
Head and body ..	215·95 ..	189·8
Hind foot ..	44·675 ..	40·6
Ear	25 ..	20·375

It thus becomes evident that, as far as undoubted adults are concerned, *L. t. grandis* exceeds *L. t. tardigradus* in all the measurements taken. In both forms the female is considerably larger than the male, but the average male *grandis* is larger than the average female *tardigradus*.

In addition to the standard measurements given in the above table, the following comparisons are worthy of note :—

	L.t. grandis (av. of two ♂♂) mm.	*L.t. tardigradus* (Av. of four adults) mm.
Head-length	59·5 ..	50·5
Acromion-olecranon	61	55·4
Olecranon-stylion	71·5	68·8
Stylion-dactylion	21·5	29·4
Ischium-knee ..	70	69·7
Knee-pternion ..	74	74

It is freely admitted that our measurements of *L. t. tardigradus* do not come up to those given by Wroughton (1917) of specimens of the Ceylon loris which he compared with his *L. malabaricus*. We presume, however, that Wroughton used the specimens collected by Major W. E. Mayor in the Bombay collection. These specimens we have already noted are not typical Ceylon lorises at all, but are large blackish animals, possibly identical with *grandis*, but at any rate distinct from the typical *tardigradus*.

For future reference, the following detailed measurements of the type specimen of *L. t. grandis* (adult ♀) are recorded[1] :—

Body	mm.	*Body*	mm.
Total length	217	Brachium	63
Head-length	56	Antebrachium	72
Ear	26	Hand	28
Bimalar width	34	Femur	73
Nasion-tip of snout	18	Crus	80
Palpebral fissure	19	Foot	47
Ht. of palpebral opening	10	Anus to tip of coccyx (a rudimentary external tail)	7
Bisacromial width	62	Clitoris	7·5

Digits	mm.
Radial styloid-tip of thumb	18
L. of index finger	8·5
,, medius	16
,, annularis	18
,, minimus	11
,, hallux	21·5
,, 2nd toe	16 (without claw)
,, claw on 2nd toe	5·5
,, 3rd toe	14·5
,, 4th toe	18·5
,, 5th toe	15

Fur

The fur of *grandis* differs in several respects from that of *tardigradus*, and in each of these it follows the rules usually occurring among animals that have distinct highland and lowland races. Thus the hill race has a thicker, heavier coat as a protection against the cooler atmosphere of its native haunts. The individual hairs in the fur of *grandis* are longer. Moreover, parts of the body which are hairless or but sparsely haired in *tardigradus* are well clothed in *grandis*. This remark applies especially to the more distal segments of the limbs. In *tardigradus* the forearm and dorsum of the hand are but sparsely haired ; in *grandis* they are clothed with a good coat of hair. On the crural segment of the hind limb, on the dorsum of the foot, and on the most posterior

1. For measurements of the skull of the type female, see p. 120.

portion of the plantar surface of the heel, *grandis* has a much heavier covering of hair than the typical Ceylon Loris. This latter arrangement gives the animal the appearance of wearing trousers and boots, and is thus in great contrast to the cadaverous limb of typical *tardigradus*. The appearance is all the more atriking, in the more typical specimens, by virtue of the colouration of the hairs of this region (*vide infra*). Other places where the body is better clothed in *grandis* are the parts around the mouth and the throat. The lips and snout region, with the exception of the naked moist area immediately around the nares, are covered in *grandis* by fine, closely-set white hairs. Amongst these are some longer, darker, stiff hairs belonging to the category of sinus hairs (Plate XXV, fig. 2).

In *L. t. grandis* the hairs are longest on the shoulders and the lateral surfaces of the trunk. Posteriorly, on the loins and flanks, the coat thins out and becomes shorter. The hairs on all parts of the trunk are of a coarser type than in the typical race; this can best be judged by gently stroking the coat with the finger tips. In the typical race a velvety texture is the rule, whilst in *grandis*, as in the Indian lorises, the smooth texture is replaced, or at least diminished, by the presence of coarser hairs among the more woolly ones. On the ventral aspect of the trunk and throat in *grandis* the hair is soft in character as in *tardigradus*, but the individual hairs are longer and more closely set, giving the front view of the face a more rounded appearance. The throat hairs are continued forwards on either side of the head to form a woolly tract anterior to the ears. On the forehead the hairs are shorter, but are nevertheless longer than in *tardigradus*.

The differences in the hairy coat of the two races of Ceylon loris are explained by the microscopic characters of the hairs. The coat of Loris, like that of most mammals, consists of two varieties of hair, present in varying proportions. First, there are ordinary wiry hairs, which are stiff and project beyond their fellows. They form the greater part of the pelage of most mammals. Then there are the shorter, softer wool hairs. In Loris these are by far the more numerous of the two, and give the soft, woolly character to the fur. The two Ceylon lorises differ in the proportions of the two kinds of hair. In *tardigradus* there are very few true hairs; almost the whole coat being formed of wool hairs, in the adult. In the new born, there are long stiff hairs projecting through the woolly coat at intervals, but most of these disappear with age. On the other hand, *grandis*, even in the adult, presents a coat containing a relatively large number of these true hairs,—sufficient in fact to do away with the characteristic velvety texture of the typical loris pelage.

These true hairs in *grandis* are found most abundantly on the dorsal surface of the trunk and on the extensor aspects of the limbs.

Colour of Fur

All Slender Lorises present wide individual variations in coat colour. In addition there are sex and age variations. All these must be taken into account in describing a new form, and it must always be borne in mind that coat colour, alone, is not sufficient evidence for the creation of new races or species. All that can be done is to take the average condition of a number of examples of the proposed new form, and compare it with the average of the typical form. These results must then be corroborated by searching for other morphological characters which may serve to distinguish the new form from the ones already known. Mistakes have already been made, from the neglect of the above, even in connection with the genus Loris, *e.g.*, basing the description of the Indian "species" *L. lydekkerianus* on the presence of a dark median stripe on the back. If *L. lydekkerianus* is distinct, some further aid to diagnosis should be given beyond a mere local alteration of coat colour. Moreover, median dorsal stripes occur quite frequently in both races of Ceylon loris, though more frequently in the typical form than in *L. t. grandis*.

Making allowances, therefore, for the variations mentioned above, we are able to state that, on the average, the typical Ceylon loris is of a general reddish colour, whilst the new race, *grandis*, is dark grey, inclining to black. There are many specimens of *tardigradus*, however, with but little of the ruddy tint, their general colour being dark yellowish brown, but never as dark as the typical specimens of *grandis*. On the other hand, we have seen several specimens of *grandis* that could not be described as blackish. They were buff-brown, with even a suggestion of reddish on the hinder parts. In both races the females tend to be darker than the males. In *tardigradus*, the new born is sometimes dark slaty-grey. The new born of *grandis* has not yet been seen.

The details of coat colouration in typical specimens of *L. t. grandis* are as follows :—Dorsal aspect of head, neck and trunk and extensor surfaces of the limbs, covered with hairs presenting three or more zones of colour. At the base, each hair is grey or black. This is followed by a lighter zone of yellowish brown. Next comes a very dark zone commencing as dark brown, but inclining to dark grey or even black as the tip of the hair is approached. Finally, on the tip of some of the hairs is a band of pure white. This last-mentioned zone gives the "frosted" appearance so often seen in lorises. It is always more evident in these highland animals than in the typical specimens of the species. The frosting is best marked on the shoulders and upper dorsal region and

on the more proximal parts of the extensor surfaces of the limbs. It is less marked on the lumbar and sacral regions, though not wholly absent thereon. Moreover, on these latter parts, the darker zone deep to the frosting is frequently not so dark as elsewhere, and the coat colour here sometimes approaches that of the typical race, inclining often to fulvous and sometimes to rufous. In one male specimen from Opalgalla (2,500 ft.) there was very little frosting, and the deeper colour bands were distinctly fulvous, so that on the body the animal resembled a female, *L. t. tardigradus*. It was only by taking size, facial appearance and characters of fur into account that this specimen could be definitely diagnosed as *L. t. grandis*. Further, these paler specimens seem to show a dark median dorsal stripe with some frequency—as is often observed in *tardigradus*. The distal parts of the limbs are clothed with shorter hair and its colour becomes paler and the frosting less than more proximally. The most distal parts are clothed with short silvery white hairs only. This white hair on the hands and feet is well marked in the Opalgalla specimen, although it so closely resembles a typical *tardigradus* in its general colouration.

The ventral aspect of the trunk and the flexor surfaces of the limbs are clothed with hair that on the surface looks pure white. This is in great contrast with the condition seen in *L. tardigradus* in which the general colour of these parts is pale buff or yellowish cream. Closer examination reveals that only the peripheral half of the hair is of the pale colour (white in *grandis*, buff in *tardigradus*), the deeper half in both forms being grey. In some specimens of *grandis*, a slight yellowing of the outer zone of the ventral hairs is to be seen, especially as the flanks are approached, but the colour is never so decidedly buff as in the typical *tardigradus*. On the distal parts of the flexor aspects of the limbs, the hair is pure white throughout. On the throat the hairs are long and woolly and are always pure white throughout their length (*i.e.*, there is no basal grey zone). This gives a characteristic appearance to the animal's face that always enables one to distinguish it from *tardigradus*.

It is in the face that some of the most characteristic colours of the hairs are to be noted. Whatever the coat colour in other parts, *grandis* seems to be well characterised in its facial markings. In general terms, *grandis* may be described as having its facial markings more contrasted than in the typical race. The white interocular stripe stands out more prominently. It is dagger-shaped in outline, broader above than below. Below it is continued as a short white hair-tract on to the snout, only the very tip of which is naked and moist. Above, the interocular stripe bifurcates, and its two branches pass peripheral to

the dark circum-ocular patches and form a pale zone intervening *between two darker ones. The bifurcation of the inter-ocular stripe* may sometimes be seen in *tardigradus,* but in this form it is never continued around the dark patches as it is in *grandis.* On the cheeks in *grandis* the pale hairs spread out and become continuous below with the white hairs on the throat, and also with short white hairs on the lateral aspects of the muzzle.

The eyelids are feebly haired with very short grey hairs, forming a narrow pale zone, around the eyelid margin. There are, as in monkeys, eye lashes on the upper lid, but not on the lower. Beyond the pale zone, comes the dark circum-ocular patch. This is darker than the corresponding area in the typical race. It is widest in the supraorbital region, where it extends upwards as a triangular dark field. On the medial side of the orbit it is very attenuated and sharply defined from the white interocular stripe. Laterally it is limited by the pale band coming round from the bifurcation of the interocular stripe, beyond which is a dark pre-auricular area. Inferiorly there is a sharp contrast between the dark patch and the white hairs of the cheek and throat.

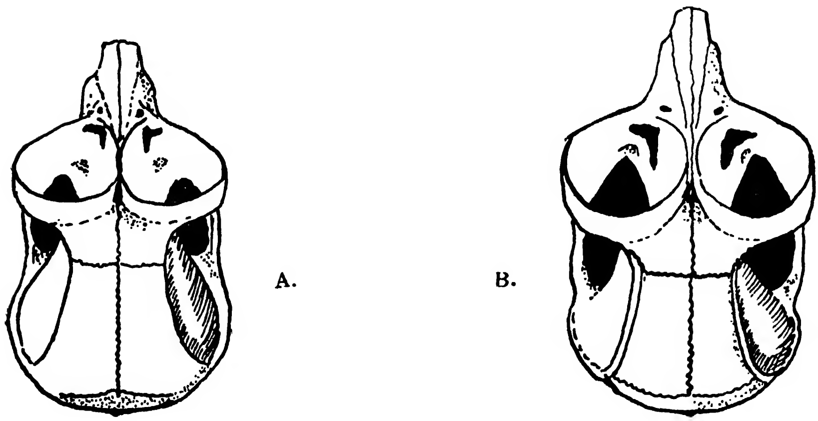
Colouration of Naked Areas

Naked areas of skin are less extensive in *grandis* than in *tardigradus,* on account of the more complete hairy covering in the former. The parts still remaining naked are the tip of the rhinarium, the palmar aspect of the hand, and the plantar aspect of the foot (except the heel). The ears are sparsely haired with greyish or whitish hairs, especially on the lateral aspect, and these extend down into the meatus. The penis and clitoris are hairless, but the neighbouring skin is well clothed. Of the colouration of the naked areas, the rhinarium and the palms and soles are delicate pink. There seems to be no melanin pigment in the hands and feet at all. The eyelid margins, however, are deeply pigmented, and a lighter shade of pigmentation occurs on the palpebral conjunctiva. The ocular conjunctiva is unpigmented, except for a slight diffuse pigmentation at the inner and outer canthi. The ears have but a slight degree of pigmentation, though this varies among individuals. A greyish tinge is seen on the naked parts of the genitalia, and around the anus. Otherwise there is little or no melanin in the skin. In specimens of *tardigradus* there frequently develops, in addition to melanin pigmentation, a diffuse yellowish tinge in the skin. This appears to affect all the skin, but is especially well seen in the naked areas. It looks exactly like jaundice, and strikes the observer as definitely pathological. So far the appearance has not been observed

with certainty in specimens of *grandis*. In *tardigradus* the condition appears rapidly in captivity, especially if the animals are fed entirely on fruit and are deprived of animal food. Under these conditions they soon die, and this accounts for the usual unsuccessful results obtained in keeping lorises more than two to three months in captivity. The condition does develop, however, in spite of proper dietetics, and animals so affected have lived, and are still living, after nine to twelve months. In the definitely pathological cases, the pigment in the skin seems to affect the nutrition of the skin and desquamation of the superficial layers occurs on the hands and feet and also on the neighbouring parts of the limbs. But not all cases are definitely pathological. We are inclined to the view that, in *tardigradus*, a certain amount of this yellow pigment is normal in the skin, its amount depending on the animal's food. It is to be regarded probably as an excretory product, retention of too much of which will cause pathological effects. It seems very strange, however, that the specimens of *grandis* which have been kept in captivity, some of them for as long as fifteen months, have so far not shown this condition, though they have shared the same food with lowland animals. In all cases, the skin of *grandis* has shown a perfectly clear pink in all the normally unpigmented naked areas.

Skull (See text figure)

The skull of *grandis* differs in a number of points from that of *tardigradus*. In the first place it is appreciably larger in all its measure-



The norma verticalis of the skull of Ceylon lorises, (natural size).

A—*Loris tardigradus tardigradus* (adult ♀); B—*Loris tardigradus grandis* (adult♂)

ments, that of the smallest adult male being larger than that of the largest adult female *tardigradus*. The size difference is much more than a mere sexual difference therefore. Apart also from sexual differences, all the muscular ridges and other markings are better developed in the skull of *grandis* than in that of the typical race. This is especially well shown in the temporal ridges, and in the curved lines on the occipital bone. The area for attachment of the temporalis muscle and the dorsal musculature of the neck is therefore more extensive and the corresponding muscles more powerful. Accessory to the increased bulk of the temporalis muscle, the zygomatic arch is found to be wider, and is of a different shape from that in the typical lorisian skull. The cavity of the arch extends further forwards, overlapping laterally as far as the front edge of the last molar tooth. The zygomatic arch forms in *tardigradus* a triangular passage, with the sides subequal. In *grandis* the passage is also triangular, but the lateral side of the triangle is much the longest. Correlated with the enlarged accommodation for the temporal muscle, the jaws are found to be larger and more strongly built and the teeth to be enlarged also. The palate, moreover, is longer, but narrower relatively than in *tardigradus*. With regard to the other facial bones, it may be noted that the osseous portion of the snout projects forwards relatively to a greater extent than in the skull of *tardigradus*. The orbital margin also stands out more prominently, especially above. The depth of the orbital rim here is 4·0 mm. in the Opalgalla specimen, 4·75 in the adult male paratype, and 4·8 in the type female. In a large female *tardigradus* the measurement was only 3·0 mm.

The following are the measurements of the skull of the type female:—

	mm.		mm.
Max. l	50·5	Palatal l ..	19
Max. br. of cranium	30	Br. across m 3	16
Skull ht. ..	23	Upper tooth row	17
Min. cranial width behind orbits ..	17	Bizygomatic width	32
Least frontal br.	14	Interorbital br.	1·5
Br. across bullae	30	Condylion-symphysion	27·5
L. of foramen mag.	6·75	Mandibular ht. (at condyle)	10·5
Br. " "	6	Lower tooth row ..	15·5

The following table serves for comparison of skull measurements in *L. t. grandis* with those of *L. t. tardigradus* :—

	L.t. grandis			*L.t. tardigradus*		
	L. 2 ♂	L. 3♂ (Paratype)	Av. of L2 & L3	Ad. ♀ (Av.of 4)	Ad.♂♂ (Av.of 4)	Ad.♀♀ (Av. of 3)
Max. length	52·75	52·5	52·6	49·5	48·8	49·8
Max. breadth of cranium ..	28·5	30	29·7	22	—	—
Skull height	24	23·5	23·75	21	—	—

	L.t. grandis			*L.t. tardigradus*		
	L. 2 ♂	L. 3♂ (Paratype)	Av. of L2 & L3	Ad.♀ (Av. of 4)	Ad.♂♂ (Av. of 4)	Ad.♀♀ (Av. of 3)
Minimum cranial br. behind orbits..	17	16	16 ·5	16	16 ·7	16 ·5
Least frontal breadth	15	14	14 ·5	12 ·5	—	—
Breadth across bullae	28	30	29	27	27 ·7	28 ·2
L. of foramen mag.	6	7	6 ·5	5 ·5	—	—
Br. of for. mag.	6	7	6 ·5	5 ·75	—	—
Palatal length	19	20	19 ·5	18	—	—
Br. across M 3	15	14 ·5	14 ·75	14	—	—
Upper tooth row (excl. incisors) ..	17	16 ·5	16 ·75	16 ·5	16 ·1	16 ·2
Bizygomatic br.	34	33	33 ·5	31	30 ·5	30 ·3
Interorbital width	1 ·5	1	1 ·25	0 ·5	—	—
L. of mandible (condylion-symph)..	28 ·5	28	28 ·25	27	—	—
Mandibular ht. (at condyle) ..	10	9	9 ·5	10	—	—
Lower tooth row (excl. incisors) ..	15 ·5	15 ·75	15 ·6	13	—	—

Distribution

The first specimen of the new race to come into our hands was caught about March, 1931, by some Tamils, while it was asleep in a clump of tall seed-bearing tea bushes on Mousakande Estate. That the animal was little known to its captors was evident from their curiosity and remarks and from the fact that many of them had not seen such a creature previously.

The bushes among which it was found are approximately 3,200 ft. above sea-level, and this is the highest altitude from which a specimen of *grandis* has, as yet, been secured.

Rewards failed to produce further specimens until the following September and October, when the local Sinhalese villagers, of the villages immediately below the estate, commenced to fell the jungles to make new " chenas." A further eight specimens were then brought in from altitudes varying from about 2,500 ft. down to 1,200 ft. Two specimens came from the Opalgalla side of the ridge, but the remainder were all from the Mousakande Valley and below.

As far as our knowledge goes, at present therefore, the range of *grandis* would appear to be limited to the hills in the immediate neighbourhood of Gammaduwa, in the Matale East district, at altitudes between 1,000 and 3,200 ft. It would also appear that the race is uncommon and sparsely distributed throughout its range.

Habits, Food, etc.

The first specimen procured was kept under observation, in captivity at Mousakande, for some months before it was sent down, with others, to Colombo. During this period many notes were made upon its behaviour and habits—some of which notes were embodied in a paper published last year (Phillips, 1931).

In general, the habits of *grandis* appear to be much akin to those of typical *tardigradus*, with the exception that, being a more powerfully built animal living in jungles where less wild fruit is available, it is evidently more carnivorous and insectivorous than its smaller, low-country cousin.

Those specimens of *grandis* which have been kept at Mousakande have enjoyed plantains (which have formed their staple food) but they have, without exception, refused all other fruits offered to them. On the other hand, they have shown a decided preference for animal and insect food. Small birds, frogs, lizards, geckoes and most insects that are not repugnant to Insectivores, have been eagerly devoured, to the neglect of plantains. Small mammals, such as mice and shrews, however, they would not touch, however hungry they might be.

It would seem most probable from our observations, that *grandis*, in nature, lives chiefly upon the tree frogs and other small arboreal vertebrata that abound in the jungles which it inhabits, together with insects of all description that are not definitely repugnant to insectivorous forms. The more powerful build and greater agility of *grandis* doubtless fits it for a more predatory life.

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EXPLANATION OF PLATES

PLATE XXV

Fig. 1. Photograph of the living adult male *Loris tardigradus grandis*

Fig. 2. Enlarged view of the face of same. (Note the characteristic facies, and especially the delicate reduced sinus hairs on the muzzle).

PLATE XXVI

Fig. 1. Drawing of the front view of the face of *Loris tardigradus tardigradus*

Fig. 2. Similar drawing of the face of *L.t.grandis*. (Both figs. are drawn to the same scale).

Fig. 1

Fig. 2

Fig. 1

cm.

OH. del

Fig. 2

Fig. 1—*Loris tardigradus tardigradus*

Fig. 2 *Loris tardigradus grandis*

Additions to the Fauna of Ceylon. No. 3

A New Pigmy Shrew from the Mountains of Central Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

(With One Plate and One Text Figure)

While at Mousakande, Gammaduwa (3,300 ft.) in 1927, I obtained a single specimen of a very diminutive shrew, which, following Blanford (1888, p. 241) I then, provisionally, referred to *Suncus perrotteti*—the Indian pigmy shrew, of Coorg and the South Indian hills. (Phillips, 1928, p. 315).

In 1930, however, I obtained two more specimens from the same locality and last year I received a further six collected at Ohiya (6,000 ft.) by my friend Mr. A. C. Tutein-Nolthenius, of West Haputale Estate, Ohiya.

A careful examination and comparison of all this new material, with Indian material very kindly loaned and sent down to me by the authorities of the Bombay Natural History Society, has shown me that the Ceylon pigmy shrew cannot be referred to *Suncus perrotteti*. Though resembling that species in general character, the Ceylon form is considerably darker in colour and larger in all dimensions.

Recently, Mrs. Helen M. Lindsay has worked out the material, of the genera Suncus and Crocidura, that was collected by the Bombay Natural History Society's Mammal Survey and has published the scientific results in a very useful paper in the Journal of that Society (Lindsay, 1929).

A study of this paper and an examination of the material returned to the Bombay Natural History Society's collections, makes it evident that the Ceylon pigmy shrew represents a new species, distinct from any of the mainland forms. I have pleasure in naming this new species in honour of Mrs. A. C. Tutein-Nolthenius, *née* Fellowes-Gordon.

Suncus fellowes-gordoni, sp. n.

The Ceylon Pigmy Shrew

Size very diminutive, the smallest of all Ceylon mammals, the head and body of the type measuring only 58 mm. Tail shorter than the head and body, not swollen at the base but mouse-like, slender and scarcely tapering, sparcely clad with minute hairs among which are scattered, specially towards the base, a number of larger hairs; muzzle slightly swollen at the sides, sparcely furred; ears rather large and prominent, naked except for fine down; feet small and delicate, semi-naked, equipped with very small claws; lateral glands well developed and musky smell pronounced in some specimens.

Fur.—Very close, short and velvety; whiskers numerous and comparatively long.

Colour.—General colour, very dark, glossy, chocolate brown to blackish brown on the upper parts; dark grey with a silvery sheen on the lower parts; throat lighter grey; muzzle dusky but flesh coloured round the mouth; ears dusky but flesh coloured where they join the head; fore feet dusky above, flesh coloured beneath; hind feet dusky, lighter beneath; claws reddish white; tail dusky above, slightly lighter beneath; whiskers dark silvery grey.

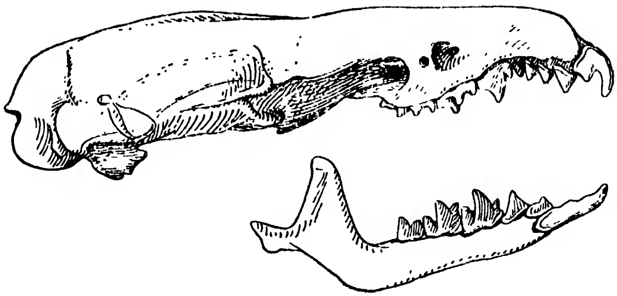
Young.—The young and sub-adults are rather darker in general hue; some are almost black.

Measurements, taken in the flesh.

Suncus fellowes-gordoni	*Head and Body*	*Tail*	*Hind foot*	*Ear*	*Head and snout*
	mm.	mm.	mm.	mm.	mm.
Of the Type ♀	58	34	9	5	—
Average of 7 ♀♀ ..	52·4	34·3	9·5	6	19
Average of 2 ♂♂ ..	48·5	36·5	9	7	19
Suncus perrotteti	mm.	mm.	mm.	mm.	mm.
Average of 3 ♀♀ ..	47·3	33·1	8·5	5·5	—

Skull

	Condylo-incisive length	*Breadth across molars*	*Inter-orbital breadth*	*Mastoid breadth*	*Dental length*	*From front 2 p to back 4 m*	*Length of upper incisors*	*Length of lower incisors*
Suncus fellowes-gordoni	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm
Of the Type ♀ ..	14·7	4·3	3·5	6·6	6·2	3·4	1·3	2·5
Average of 4 ♀♀ ..	14·7	4·3	3·5	6·7	6·2	3·3	1·5	2·5
Average of 1 ♂ ..	14·2	4	3·2	6·5	6·2	3	1·5	2·5
Suncus perrotteti	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Average of 3 ♂♂ ..	13·5	4	3·1	6·2	5·3	3	1·2	2·



Skull of *Suncus fellowes-gordoni* × 5⅓

Type.—I have selected as the type of the species, an adult ♀ (No. T.N. 2) collected by Mr. A. C. Tutein-Nolthenius, at West Haputale, on February 6th, 1931. It is not a very satisfactory specimen but it is the best available.

The type, together with one or two paratypes, is being presented to the British Museum collections, through the kindness of Mr. Tutein-Nolthenius. Other paratypes are being deposited in the Colombo Museum.

Type locality.—West Haputale, Ohiya, Uva Province, Ceylon, altitude 5,200 ft. to 6,000 ft. The type locality is a tea estate surrounded by mountain forests.

Remarks.—This little shrew appears to be not uncommon around West Haputale, Ohiya, and it is probable that it is well distributed throughout the higher hills of the Uva and Central Provinces. Being so minute it is very easily overlooked and its presence might remain undetected for many years.

It is very probable that it was this species that was found by Dr. Kelaart, at Nuwara Eliya, about the year 1850. On page 32, *Prodromus Faunae Zeylanicae* he has written " at the time we were collecting shrews and rats at Nuwara Eliya, a few tiny shrews were brought to us as young shrews; which were put into spirits for further examination but not *one* of them was in a fit state for examination on their arrival in Colombo. We are, however, strongly inclined to believe that they are allied species, or identical with Hodgson's *Sorex pigmaeus* found in the plain of Nepal, they were nearly of the same dimensions. The body well clad in fur, colour uniform sooty black, with pale fulvour grey tips to some parts of the fur above. Much paler beneath."

In the Gammaduwa Hills this species is distinctly rare but several specimens have been found, within the last few years, in field drains and under boulders. In these hills, *Crocidura horsfieldi*, another very small shrew is the more common but in the higher hills the present species appears to be the commoner.

Although probably chiefly nocturnal in its movements, one or two specimens have been caught while active during the daytime, in dull weather.

I have much pleasure in acknowledging my indebtedness to the authorities of the Bombay Natural History Society, for their courtesy and kindness in sending down to me many specimens of Indian pigmy shrews for purposes of comparison. I am also greatly indebted to Mr. G. M. Henry, of the Colombo Museum, for the excellent sketch, from life, that he has made of the living animal as well as for that of the skull.

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EXPLANATION OF PLATE

PLATE XXVII

Suncus fellowes-gordoni, sp. nov. × 2·5

Suncus fellowes-gordoni, sp. nov.

Survey of the Distribution of Mammals in Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

REPORT No. 4

Collection	No. 5.
Locality	West Haputale, Ohiya.
Date	July to December, 1931.
Collected by	A. C. Tutein-Nolthenius, Esq.

(*See also Report No. 1*)

This report is on a supplementary collection made by Mr. A. C. Tutein-Nolthenius, at West Haputale Estate, Ohiya, during the second half of 1931.

In making this second collection, Mr. Tutein-Nolthenius has omitted to collect many specimens of the commoner species which were represented, so fully, in his first collection. He has concentrated on the more uncommon and rare forms, several of which did not appear in his first collection.

Taken as a whole, the collection is one of the most interesting that I have examined. Although it contains no forms new to science there are several species represented in it that have hitherto been known from one or two specimens only. The most interesting of these are the *Feroculus feroculus* (Kelaart), *Crocidura miya* Phillips and *Vandeleuria nilagirica nolthenii* Phillips. It is curious, however, that no second specimen of *Rattus montanus* has come to hand.

Mr. A. C. Tutein-Nolthenius is to be congratulated on his work in making another collection of so much interest and value.

(For a description of the locality, see Report No. 1)

(No. 31) Feroculus feroculus (Kelaart)

Kelaart's Large-clawed Shrew

♀♀ 2; typical.

Two fine specimens of the very rare long-clawed shrew, discovered by Dr. Kelaart in Nuwara Eliya in 1850. Both were caught in a ravine not far from West Haputale bungalow, the first being taken in a trap baited with coconut and the second, two nights later, being taken with

meat. They are, I believe, the first females of this most interesting animal to be obtained. Both specimens are in excellent condition. One has been donated to the British Museum and the other to the Colombo Museum.

(No. 34) **Suncus montanus** (Kelaart)

The Ceylon Highland Shrew

♂♂ 8, ♀♀ 6; all in alcohol and all quite typical.

A very common shrew in the jungles surrounding West Haputale Estate and in the highlands generally.

(*See also Report No. 1*)

(No. 37) **Suncus fellowes-gordoni** Phillips

The Ceylon Pigmy Shrew

♂ 1, ♀♀ 2; all in alcohol.

These additional specimens, of a very diminutive shrew, are most welcome. Together with the ones taken previously they show, on comparison with specimens of *S. perrotteti* and other forms from the Indian mainland, that the Ceylon form is a distinct species.

(*See also Report No. 1*)

(No. 39) **Crocidura horsfieldi** Tomes

Horsfield's Shrew

♂ 1; quite typical.

The occurrence of this little shrew, at this altitude, is most interesting and extends the range of the species considerably. Hitherto it has been known only from the mid-country Kandyan hills, at an altitude of between 4,000 ft. and 2,500 ft. The present specimen was caught in the store room of the bungalow, so it is always possible that it was an importation.

(*See also Report No. 2*)

(No. 40) **Crocidura miya** Phillips

The Long-tailed Shrew

♂ 1; in alcohol. ♀ 1; both typical.

This species was described, in 1928, from a single specimen caught near Galaha (3,000 ft.) in the Central Province. These two new specimens, the second and third to be obtained, are therefore of the greatest interest.

They both correspond to the type in every detail. They were both trapped in heavy jungle.

(No. 72) **Funambulus sublineatus obscurus** (Pel. & Kohl.)

The Ceylon Dusky Striped Jungle Squirrel

♂♂ 2 ; in alcohol ; both typical.

These two specimens were taken, as before, in traps set for rats in the jungle. On both occasions the bait was a small piece of coconut.

(*See also Report No. 1*)

(No. 77) **Rattus rattus kelaarti** (Wroughton)

The Ceylon Highland Rat or Kelaart's Rat

♂♂ 2, ♀♀ 2 ; all in alcohol.

Three of these are interesting as showing the juvenile colouring of this highland race. In two of them, taken from towards the bottom of the estate (altitude about 4,500 ft.), the fur is rather shorter than in typical specimens—this is, no doubt, due to the lower altitude.

In the adult male, the tail is remarkably short, measuring only 150 mm. against 160 mm. for the head and body ; presumably the tail was damaged while the animal was still living.

(*See also Report No. 1*)

(No. 78*a*) **Rattus ohiensis** Phillips

The Ceylon Bicoloured Rat

♂♂ 4, ♀♀ 2, juveniles. ♂ 1 ; all in alcohol.

As in the first collection, many of the present specimens have a variable portion of the tip of the tail pure white ; this white portion varies from 31 mm. in one of the females, to a little as a few millimetres in one of the males. It would appear to be purely an individual peculiarity. These specimens were all trapped in the forest bordering the estate ; the species is evidently common in these jungles.

(*See also Report No. 1*)

(No. 80) **Mus dubius** Hodgson

The Common Indian House Mouse

♀ 1 ; in alcohol.

Quite typical in colour and measurements.

(*See also Reports Nos. 1 and 2*)

(No. 81) **Leggada booduga fulvidiventris** (Kelaart)

The Ceylon Field Mouse

♂ 1; ♂♂ 2, ♀♀ 2; in alcohol; all typical.

This field mouse had not been reported, previously, from such a high altitude. It would now appear likely that it has an Island-wide distribution, from the sea coast to the slopes of the highest mountains. Mr. T. B. Fry has shown in his paper (J.B.N.H.S. XXXIV, p. 920, 1931) that the Ceylon field mouse should be regarded as a form distinct from the mainland mouse.

(*See also Report No. 2*)

(No. 82) **Coelomys mayori** Thomas

Mayor's Coelomys or Spiny Rat

♂♂ 3, ♀♀ 4; all in alcohol.

This series again illustrates how very variable is the colour of the belly in this species. In only three (Nos. 126 ♀, 123 ♂, 62 ♀) is the belly typically grey. In No. 139 ♀ it is greyish white, while in Nos. 94 ♂, 60 ♀, and 81 ♂ the belly is grey with the chest white. I feel sure that when specimens from lower altitudes are secured, it will be found that the mountain form, *mayori* grades, gradually, at lower altitudes, into the low- and mid-country white bellied form, *bicolor*, and that the two species, at present recognised, are in reality but two geographical races of the one species.

As before, these Spiny Rats were caught in the jungle.

(*See also Report No. 1*)

(No. 84*a*) **Vandeleuria nilagirica nolthenii** Phillips

The Highland Tree Mouse

♂ 1, ♀♀ 2; quite typical.

This race was described, in 1929, from two male specimens, collected at West Haputale, from a hollow tree. The present females are therefore the first to be obtained for examination. They closely resemble the male in all respects. A male and female were found drowned, after a storm, in the guttering round West Haputale Bungalow; the other female was caught in the stable.

(No. 85) **Golunda ellioti newera** Kelaart

The Nuwara Eliya Bush Rat

♂♂ 2, ♀♀ 3;
♀♀ 3, ♀♀ 4; juveniles in alcohol } ; all typical.

Although this species was not represented in the first collection, which was made chiefly in heavy jungle, it would appear to be fairly common around West Haputale. The present series is an excellent one and shows well the characteristics that distinguish the highland race from the lowland representative. The fur of all the present specimens is typically soft and is longer and darker than in the lowland race. Some of these specimens were trapped in grass land and others on the borders of the jungle. These Bush rats are chiefly diurnal in their habits and are generally found in pairs, or in family parties with their young.

Mr. A. C. Tutein-Nolthenius has made two very useful and interesting collections at West Haputale; it is to be hoped that he will continue to collect in other parts of the Island.

REPORT No. 5

Collection	No. 6.
Locality	Sigiriya District, Central Province.
Altitude	650 feet (approx.)
Date	17th/21st November, 1931.
Collected by	Colombo Museum Collector.

The collector who made this small collection was sent to the Sigiriya District with the object of procuring, for examination purposes, one or two specimens of Pithecus monkeys of the *senex* group, which were reported as being common in the jungles a few miles east of Sigiriya. He was also instructed to bring back specimens of any other mammals that he came across.

Sigiriya lies in the low-country just beyond, and to the north of, the foot hills on the outskirts of the East Matale range of hills, in the Central Province. It is a very small village, lying in the heart of the jungle, notable for the famous rock stronghold of early Sinhalese times. The only cultivation, in the immediate neighbourhood, is a few acres of paddy fields lying beneath the village tank and the small gardens surrounding the village huts. The mean altitude is approximately 650 feet above sea-level.

Being situated in the dry zone, the annual average rainfall, of 67·73 inches falling in 81 days, is badly distributed. During the North-east Monsoon, from October to the middle of January, the bulk of

the rain falls and the country is green and fruitful ; but from February to September it is subject to prolonged droughts and is generally arid and parched with almost no water available except in the village tanks.

The collector was in the district for a few days only and this collection is a meagre one. The most interesting specimens are those of the *Pithecus senex* monkeys which would appear to belong to the typical race—at present not represented in any of the Museums of Europe, except by the one or two aberrent albino specimens, collected nearly three-quarters of a century ago, from which the species was first described.

(No. 1) **Macaca sinica** (Linné)

The Toque Monkey

This species is very numerous in the jungles around Sigiriya and on the rock itself, but no specimen occurs in the present collection. I have noticed parties of these monkeys sheltering from the midday sun in the shade cast by the ruins on the lower slopes of the rock.

(No. 2) **Pithecus entellus thersites** (Blyth)

The Ceylon Langur

—— 1 ?

Langurs and Macaques are both common in the jungles of the neighbourhood. Troops of both species appear to keep more or less to themselves but yet are on quite good terms with each other and with the Dusky Wanderoos when they meet in the same jungles. Sometimes in the evenings, in the dry weather, all three species may be observed congregating in the tall trees round some of the abandoned tanks, to the east of Sigiriya.

(No. 3*a*) **Pithecus senex senex** (Erxleben)

The Dusky Wanderoo

1 ♂, 1 ♀.

These two specimens are of great interest. They appear, from a preliminary examination, to be identical with a similar specimen from the Gammaduwa hills, in East Matale, the type locality of the typical race of the species. Gammaduwa cannot be more than 20 to 30 miles, in a direct line, from Sigiriya ; it would appear, therefore, that, as expected, the typical race of *senex* spreads from the hills of Matale East down into the surrounding low-country. It was with the idea of clearing up this point that the collector was sent to Sigiriya. The

present specimens, together with others of the other Ceylonese races of *Pithecus senex*, will, it is hoped, form the subject-matter of a special paper on the *senex* group by Dr. Osman Hill.

(No. 10) **Cynopterus brachyotus ceylonensis** Gray

The Ceylon Short-nosed Fruit Bat

♂♂ 2, ♀♀ 5, juveniles ♂♂ 2.

This is a useful series in which all the ♀♀s show a pronounced russet hue to the mantle. This russet mantle is not as bright as in the two ♂♂s, but it is much more pronounced than is commonly found. The two juvenile males, on the other hand, are plain olive, without any russet on the mantle. As in other series that I have examined, the differences in relative size are pronounced. The measurements of the largest and the smallest ♀♀s are as follows:—

Forearm mm.	*Head and Body* mm.	*Tail* mm.	*Hind foot* mm.	*Ear* mm.
70	101	9	18	20
63	96	15	14	20

while the two ♂♂ measure respectively :

62	93	6	15	17
67	96	9	16	19

In my experience, like variations will be found in all series of specimens of this Bat.

(*See also Report No. 2*)

(No. 22) **Hesperoptenus tickelli** (Blyth)

Tickell's Bat

♂ 1, ♀ 1.

These two specimens are both quite typical. The species would appear to have a very wide distribution throughout the low-country and lower hills to an altitude of roughly 3,500 feet. It is a very common species, much in evidence in the evening, flying over open spaces.

(*See also Report Nos. 2 and 3*)

(No. 65*a*) **Ratufa macroura sinhala** Phillips

The Common Ceylon Giant Squirrel

♂♂ 2, ♀ 1.

These three specimens are all of the usual small low-country type, but in colour they are inclined to be a little darker than typical specimens of *sinhala*. This is, in all probability, due to the proximity of

the foot hills and the range of the submontane race, *dandolena*. In the female specimen, the ragged coat is dirty buffy brown and the colour change appears to be about to take place ; in the other two the change is almost completed and the coat darker.

(See also Report No. 3)

It is to be hoped that a fuller collection will be made from this locality at a later date.

REPORT No. 6

Collection	No. 7.
Locality	Southern (Palatupana) Resident Sportsman's Reserve, Southern Province.
Altitude	10 ft. to 50 ft. above sea-level.
Date	12th to 21st December, 1931
Collected by	A. C. Tutein-Nolthenius, Esq.

(See also Report No. 3 on Collections Nos. 3 and 4)

In December, Mr. A. C. Tutein-Nolthenius again visited the Southern Resident Sportsman's Reserve and made a second small collection. He took down a taxidermist collector with him, with numerous traps, and was successful in making an interesting collection of small rodents. He was, however, unfortunately, unable to secure any specimens of the small shrews that are believed to occur in that neighbourhood, and of which specimens are especially required for examination purposes.

The only surprise in this collection is the three specimens of the Ceylon Spiny Mouse, a species that has not appeared in any previous collection from this locality. The spiny mouse was discovered in Ceylon as lately as last year, when three specimens were taken at Kumbalgamuwa (3,000 ft., C.P.) and the new species, *Leggadilla fernandoni*, was described.

For description of the locality, where this collection was made, see Report No. 3.

(No. 65*a*) **Ratufa macroura sinhala** Phillips

The Common Ceylon Giant Squirrel

♀ 1. **Yala.**

A small, youngish female, with a very light isabelline coat, showing the light colour phase at its maximum and therefore an interesting specimen. One or two more specimens of this squirrel, taken at other

times of the year, but in the same locality, would be of interest for purposes of studying the colour change in this race.

(See also Report No. 3)

(No. 73) **Tatera ceylonica** Wroughton

The Ceylon Gerbil or *Antelope Rat*

♂ 1, ♀ 1, Yala.
♂ 1, ♀ 3, Buttawa Modera.
♂ 1, ♀ 4, in alcohol. Buttawa Modera.

A good series of excellent specimens; trapped among the sand dunes and also amongst the scrub further inland. This species is very numerous throughout this area.

(See also Report No. 3)

(No. 76) **Rattus rattus kandianus** (Kelaart)

The Common Ceylon House Rat

♀ 1. Yala.

Trapped in the jungle. This single specimen of the common rat is of the sandy rufescent variety. Evidently the common rat is not nearly so numerous in this area as the Gerbil and the Soft-furred rat.

(See also Report Nos. 2 and 3)

(No. 79) **Millardia meltada** (Gray)

The Soft-furred Rat

♂♂ 3, ♀♀ 2. (One sub-adult) Buttawa Modera.

All trapped amongst rocks, not far from the seashore. An interesting series of specimens, all quite typical. There is a colony of these rats at Buttawa, but they do not appear to be common at any other place within the Reserve.

(See also Report No. 3)

(No. 79*a*) **Leggadilla fernandoni** Phillips

The Ceylon Spiny Mouse

♂ 1, ♀ 1. Yala.
♂ 1. Buttawawa.

The occurrence of the spiny mouse, in this neighbourhood, is both interesting and unexpected; its presence was unsuspected hitherto. The three specimens obtained are all very similar to Kumbalgamuwa

specimens both in measurement and colour. As with those specimens, the old male is very considerably more rufescent than either the younger male or the female. The female is evidently a young animal; the colour of upper fur is greyish brown with only a slight rufescent tinge. Unfortunately, the mammary formula cannot be obtained from this specimen.

REPORT No. 7

Collection	No. 8.
Locality	Gunner's Quoin District, N.C.P.
Altitude	Approx. 200 feet.
Date	March 22nd/24th, 1932.
Collector	Mr. E. C. Fernando, Taxidermist, Colombo Museum.

Whilst visiting the Gunner's Quoin district, for a few days, with the object of shooting a Rogue Elephant, Mr. E. C. Fernando took the opportunity to collect a few of the small mammals that occur in that neighbourhood. He took down numerous traps with him. But, as usual in the jungles of the dry zone, the results obtained from them were poor. He did, however, succeed in trapping a single specimen of the White-tailed rat (*Rattus blanfordi*) that had only once, previously, been obtained in Ceylon. The previously obtained specimens were both juveniles, so Mr. Fernando's specimen, an adult male, is of great interest.

The Gunner's Quoin district lies a few miles south-east of Polonnaruwa, in the North-Central Province, and some 30 miles due West of Kalkudah on the East Coast. With the exception of Gunner's Quoin itself, the district is almost flat. It is very sparcely inhabited, there being only one or two isolated villages dotted about in the jungle. A few small patches of cultivation exist round the villages and under the village tanks, but otherwise the country is almost entirely dry zone jungle. The rainfall averages about 64½ inches of rain annually, far the greater part of which falls from October to January, during the north-east monsoon period.

It is to be hoped that Mr. Fernando will be able to make a further collection from this district, at some future date. This part of the country has not been collected in previously and a representative collection might yield some very interesting results. Gunner's Quoin itself, rising to 1,733 feet, like an Island in the flat sea of jungle would, most probably, well repay a visit.

(No. 12) **Rhinolophus beddomei sobrinus**

The Great Indian Horse-shoe Bat

1 ♂ (damaged); in alcohol. 3 miles from Gunner's Quoin.

"Shot from a hollow tree. Only one seen."

(*See also Report No. 3*)

(No. 17) **Megaderma spasma ceylonensis**

The Ceylon Vampire Bat

1 ♂; typical. Yonandamana, Alakanagoda.

"Captured from a hollow tree, from a colony of about ten." It is interesting to find that this Bat exists in these jungles. Its presence has been suspected, but no specimen has previously been secured.

(*See also Report No. 2*)

(No. 20) **Pipistrellus coromondra** (Gray)

The Coromandel Pipistrelle

1 ♂, juvenile; in alcohol. Manampitiya.

Smaller and darker than fully adult specimens. "Shot flying over at dusk."

The common Pipistrelle of the dry zone.

(*See also Report No. 2*)

(No. 22) **Hesperoptenus tickelli** (Blyth)

Tickell's Bat

1 ♂; quite typical. Alakanagoda (near Gunner's Quoin).

"Shot flying over at dusk." A very common species throughout the low-country.

(*See also Report Nos. 2, 3 and 5*)

(No. 65*b*) **Ratufa macroura sinhala** Phillips

The Common Ceylon Giant Squirrel

1 ♂; prepared for mounting. Alakanagoda (near Gunner's Quoin).

This specimen is apparently undergoing a seasonal change in coat and (in consequence) of colour. The new hairs are showing through in many parts of the fur; they are considerably darker than the old faded hairs.

(*See also Report Nos. 3 and 5*)

(No. 78) **Rattus blanfordi** (Thomas)

The White-tailed Rat

1 ♂. **Alakanagoda (near Gunner's Quoin). " Trapped in the jungle."**

This very interesting specimen is the first adult, of the species, to be recorded from Ceylon. Previously, the species was known in the Island only from two half-grown specimens caught, during August, 1920, in a bungalow at Dammeria, Passara (3,000 ft. alt.) in the Uva Province.

The present specimen appears to answer very well to the description of the species given in Blanford's Mammalia (No. 278, p. 411) with the exception that it would seem to be a little smaller. Possibly it may prove to be a distinct Island race.

The measurements of the present specimen are :—Head and body 143 mm., tail 185 mm., hind foot 33 mm., ear 23 mm.

Skull.—Greatest length 38·5 mm., condylo-incisive length 35·5 mm., zygomatic breadth 17·7 mm., least interorbital breadth 6·5 mm., brain-case breadth 15·2 mm., upper molar series 6 mm.

I shall look forward to examining more specimens, of this rat, when another collection is made in the Gunner's Quoin or neighbouring districts.

Contribution to Ceylon Helminthology
1. Paradistomum lanka, sp. nov. a parasite from the gall-bladder of the Unicorn Lizard of Ceylon

BY

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(With Four Text Figures)

In 1905 a Trematode was found in the gall-bladder of the Unicorn Lizard *Ceratophora stoddarti* from Nuwara Eliya (C.P.) and was identified as a Distomid by Looss (1908) who suggested that it might be a new genus. The state of preservation of the specimen, however, did not admit of a full diagnosis being made. Recently Mr. D. R. R. Burt, Lecturer in Zoology, University College, Colombo, obtained some Distomids from the gall-bladder of *C. stoddarti* collected at Hakgala, near Nuwara Eliya. I am satisfied that Mr. Burt's specimens are identical with the Trematode examined by Looss. It has proved to be a new species of the genus Paradistomum for which the name *Paradistomum lanka* is proposed.

The lizards obtained by Mr. Burt were preserved in alcohol after their abdominal cavities had been opened, the parasites being preserved *in situ*. A few worms, however, were preserved in Bouin's Fluid and these afforded excellent material for the purpose of sectioning. Measurements of the various organs were made from sections of the largest specimen. So far this parasite has not been found in *Ceratophora tennenti*.

A description of the new species is given below.

Paradistomum lanka, sp. nov.

External appearance

The body is flattened dorso-ventrally and is oval in shape. The anterior end is somewhat pointed, the posterior half is somewhat rounded

and is blackened by the presence of eggs in the much coiled uterus. The largest specimen measures 2·8 mm. in length and 1·8 mm. in its broadest region.

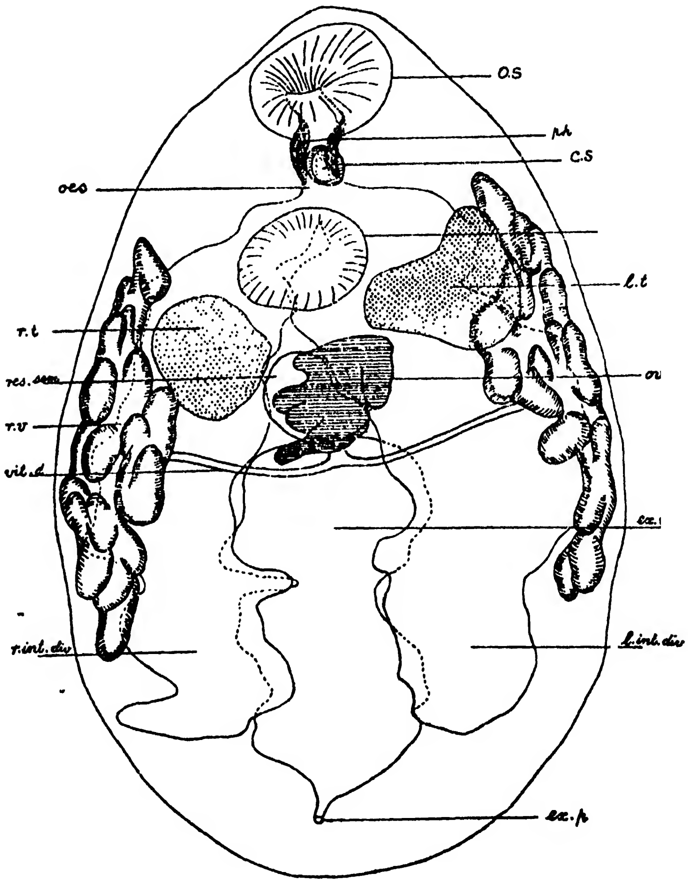

Fig. 1. *Paradistomum lanka* : ventral view from a reconstruction, × 30.

cs., cirrus sac. *ex.p* excretory pore. *ex.ves.*, excretory vesicle. *l.int.div.*, left intestinal diverticulum. *l.t.*, left testis. *oes.*, oesophagus. *o.s.*, oral sucker. *ov.*, ovary. *ph.*, pharynx. *res.sem.*, receptaculum seminis. *r.int.div.*, right intestinal diverticulum. *r.t.*, right testis. *r.v.* right vitelline glands. *v.s.*, ventral sucker. *ves.sem.*, vesicula seminalis. *vit.d.*, vitelline duct.

The oral sucker is situated at the anterior end of the body and has a diameter of 0·45 mm. ; it is placed about 0·45 mm. from the ventral sucker which has a diameter of 0·38 mm.

Alimentary canal

The mouth lies at the anterior end of the oral sucker ; the cavity of the sucker measures 0·27 mm. The pharynx lies immediately behind the oral sucker. It is small and globular, measuring 0·18 mm. in length and in diameter. The pharynx is followed by a short oesophagus which measures 0·08 mm. in length and from the oesophagus branch out the two intestinal diverticula which extend to about 0·5 mm. from the posterior end of the body. Each diverticulum measures 0·5 mm. in diameter. The intestinal diverticula lie dorsal to the uterine coils at the posterior region. (Text fig. 2, *int. div.*)

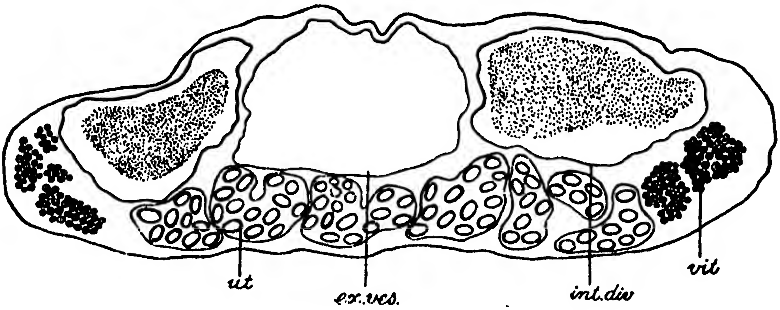

Fig. 2. Transverse section of the posterior region of *Paradistomum lanka*. *ex.ves.*, excretory vesicle. *int.div.*, intestinal diverticulum. *ut.*, uterus. *vit.d.*, vitelline duct.

Excretory system

The excretory pore is postero-dorsal in position, and is situated 0·17 mm. from the posterior end. The excretory vesicle, which is large and elongate, is situated dorsally in the posterior region of the body between the intestinal diverticula. In some specimens the wall of the vesicle is closely applied to the dorsal body wall. The excretory vesicle measures 1·13 mm. in length and 0·56 mm. in diameter. The receptaculum seminis lies immediately in front of the excretory vesicle.

Reproductive system

The testes are rounded and in some specimens are slightly lobed. They lie below the intestinal diverticula and are asymmetrical in position. The left testis which is larger, measuring 0·5 mm. in diameter and 0·45 mm. in length, is situated in front of the ovary reaching to the most anterior limit of the ventral sucker ; the right testis measuring

0·38 mm. in diameter, lies to the side of the ovary a little in front of the posterior limit of the ventral sucker. The vasa deferentia meet in the middle line at the anterior end of the body under the intestinal bifurcation and form a short, median vas deferens, which leads into the vesicula seminalis. The cirrus sac, measuring 0·2 mm. in length and 0·12 mm. in diameter, contains the vesicula seminalis. The sac is thick walled and may be divided into a deeper region containing the vesicula seminalis and the region next the genital atrium in which lies the short, muscular cirrus. In the latter region lie the simple prostate gland cells. The vesicula seminalis has a characteristic structure which is best seen in section (Text fig. 3). A deep constriction divides the vesicula seminalis into a dorsal and a ventral chamber; and the constriction apparently acts as a sphincter muscle; the cytoplasm of the cells of the wall in this region stains deeply. The wall of the ventral chamber is thicker than that of the dorsal chamber. Spermatozoa from the vas deferens enter the dorsal chamber, pass through the constricted region into the ventral chamber from which they enter the cirrus.

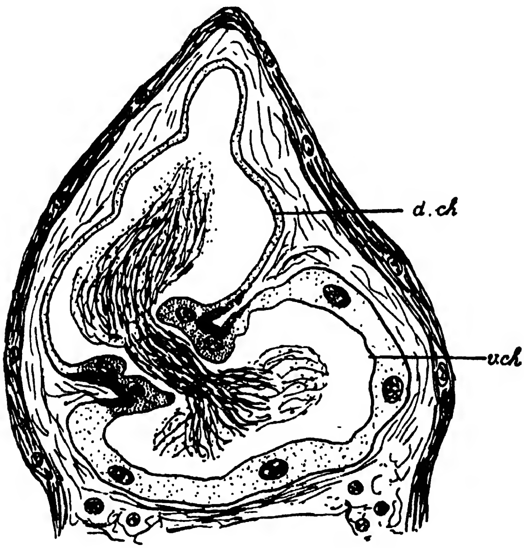

Fig. 3. Portion of a sagittal section of cirrus sac showing the dorsal and ventral chambers of the vesicula seminalis.

d.ch., dorsal chamber of vesicula seminalis. *v.ch.*, ventral chamber of vesicula seminalis.

The ovary, measuring 0·4 mm. in diameter, is lobed, and is situated ventrally, somewhat to the left of the middle line. The posterior end of the ovary lies at the same level as the anterior end of the excretory vesicle. The receptaculum seminis is large, measuring 0·4 mm. in length and 0·33 mm. in diameter. It lies directly above the ovary, situated in the space between the intestinal diverticula and the anterior end of the excretory vesicle. The receptaculum seminis is filled with spermatozoa.

From the ovary the germiduct passes upwards and backwards, meeting a duct coming ventrally from the receptaculum seminis. The common duct, thus produced, passes posteriorly to open into the ootype, around which is situated the shell gland. The shell gland is a large, compact mass, situated between the posterior ends of the receptaculum seminis and the ovary. It is about 0·3 mm. in diameter.

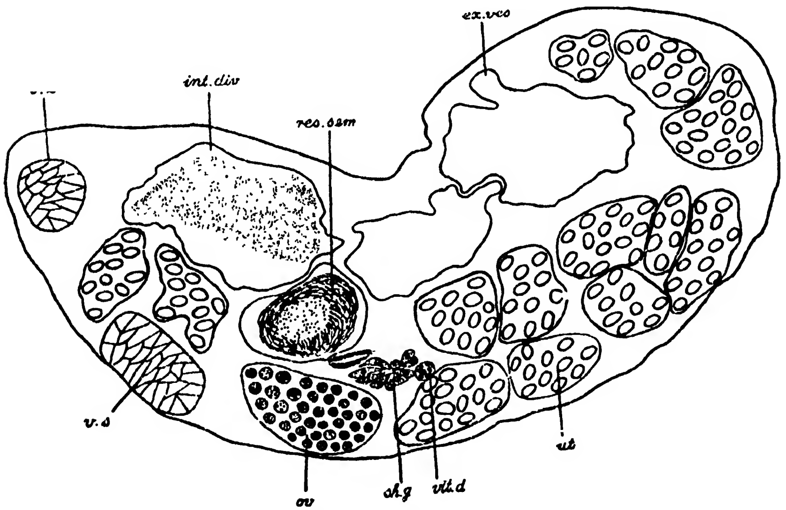

Fig. 4. Sagittal section of *Paradistomum lanka*.

ex.ves., excretory vesicle. *int.div.*, intestinal diverticulum. *o.s.*, oral sucker. *ov.*, ovary. *res.sem.*, receptaculum seminis. *sh.g.*, shell gland. *ut.*, uterus. *v.s.*, ventral sucker. *vit.d.*, vitelline duct.

The vitellaria lie at the lateral margins of the body and are compact, lobate glands. Their length (1·4 mm.) is half the total length of the body. They are placed asymmetrically; the left vitellaria extend in front of the ventral sucker, their anterior limits being on a level with the cirrus sac. From about the middle of each a duct travels across

the body, these ducts meeting just behind the shell gland to form a common vitelline duct which travels forwards into the ootype.

There is no Laurer's canal.

The uterus leads from the ootype. It is much coiled, filling the whole posterior ventral region of the body. It extends beyond the intestinal diverticula posteriorly and also lies along the margins of the body lateral to the intestinal diverticula at the posterior half of the body. The uterus follows a convoluted path to the anterior end where it opens into the genital atrium.

The eggs measure 0·040 to 0·044 mm. in length and 0·020 to 0·028 mm. in diameter.

The genital pore is median, situated between the two suckers a little in front of the bifurcation of the intestine.

Relationships of Paradistomum lanka

There exists at present some confusion between the two genera Dicrocoelium (Dujardin, 1845) and Paradistomum (Kossack, 1910). Travassos (1919) separated the I icrocoeliinae into two groups, which, apart from their anatomically distinguishing characters, were parasitic the one group in warm-blooded animals, (Aves and Mammalia), and the other group in cold-blooded animals (Batrachia and Reptilia). Dicrocoelium belongs to the first group and Paradistomum to the second, so that this parasite of Ceratophora belongs to the genus Paradistomum. But the classification of Trevassos has been questioned by Dollfus (1922) who showed that nature of host alone is not a sufficient basis for classification. Dollfus proposed the genus Paradistoma which was intended to supersede the genus Paradistomum of Kossack (1910), as the latter had been defined from a single species *P. rabusculum*, as he considered the definition inadequate, and as he wished to include species of other genera in his new genus. To this end Dollfus modified slightly Kossack's definition, the principal addition being the characters of the vitellaria which in Paradistoma he defined as follows :—" vitellogènes formés d'un petit nombre d'assez gros follicules, s'étendant sur une hauteur relativement faible, ne dépassant pas antérieurement les testicules, et débutant généralement en arrière de ceux-ci."

In the species here described the vitellaria extend in front of the testes although agreeing in other respects with the characters of Paradistoma (Dollfus), and the extent of the vitellaria in front of the testes may also be seen in Looss's incomplete figure. It is obvious then, that if the characters proposed by Dollfus are valid characters, this parasite does not belong to the genus Paradistoma. The older genus Para-

distomum (Kossack) is therefore retained as Kossack's definition applies to this specimen.

At the same time, the description of new species of Dicrocoeliinae in India by Narain and Das (1929), which are included in the genus Dicrocoelium, but which properly belong to the genus Paradistomum, shows that the Dicrocoeliinae are in need of revision.

Paradistomum ceratophorae resembles *Dicrocoelium indica* Narain and Das, in that the oral sucker is larger than the ventral, in the relatively larger size of the left testis and in the absence of Laurer's canal. Looss (1908), from his superficial examination, remarked that the Distomid which he reported on resembled *Distomum mutabile* Molin (*Paradistoma mutabile*) as redescribed by Lühe (1900), but the state of preservation of the specimen did not admit of giving a full diagnosis of the genus. A detailed comparison of these two forms indicates that they belong to the same genus although exhibiting differences which are of specific value.

Dollfus (1923) proposed the provisional name *Paradistoma ceratophorae* for the specimen reported on by Looss. The name *Paradistomum lanka* is now proposed for this animal which is described here for the first time.[1]

Diagnostic characters

Host : *Ceratophora stoddarti*, in the gall-bladder.

Type locality : Hakgala, Ceylon.

Size : 2·8 mm. in length ; 1·8 mm. in breadth ; ovoid in shape.

Suckers : Oral sucker 0·45 mm. ; ventral sucker 0·38 mm. ; o.s. : v.s. : 8 : 7.

Pharynx : globular ; diameter 0·18 mm.

Oesophagus : short ; 0·08 mm. in length.

Intestinal diverticula : reach to about 0·5 mm. from the posterior end ; diameter 0·5 mm.

Excretory vesicle : elongated and simple ; length 1·13 mm., 0·56 mm. in diameter.

1. This raises an interesting point in zoological nomenclature.

In 1908 Looss examined a Distomid found in the gall-bladder of *Ceratophera stoddarti* from the Nuwara Eliya district. Owing to its badly preserved condition Looss was unable to identify the parasite. He gave a drawing of the complete parasite but did not give any sectional drawings. His description was inadequate as he was unable to satisfy himself on many anatomical points. Fifteen years later Dollfus gave a provisional name to this imperfectly described form although he did not see the specimen.

A similar parasite has now been found in the same region of the same host from the same locality. It agrees with Looss's imperfect description and it is morally certain that the two forms are identical. The question of identity, however, is not very important and can never be verified as Looss's specimen cannot be traced, but it is important that Mr. Fernando has given a full description of this form for the first time. In my opinion the name he proposes should stand and the name proposed by Dollfus in 1923 should be ignored.—*Editor, C. J. Sc.*

Testes: asymmetrical in position; right testis round, 0·38 mm. in diameter; left testis lies in front of the right, 0·5 mm. in diameter, 0·45 mm. in length.

Cirrus sac: 0·2 mm. in length, 0·12 mm. broad.

Cirrus: short, 0·085 mm. in length.

Vesicula seminalis: divided by a muscular constriction into two chambers, one dorsal and one ventral.

Ovary: large and lobed; diameter 0·4 mm.

Receptaculum seminis: situated directly above the ovary; 0·4 mm. in length, 0·33 mm. in diameter.

Vitellaria: large, compact and lobate; extending lateral and ventral to the intestinal diverticula; 1·4 mm. in length.

Uterus: much coiled and filling the whole of the postero-ventral region of the body.

Eggs: blackish; 0·040 to 0·044 mm. by 0·020 to 0·028 mm.

Genital pore: slightly in front of the intestinal bifurcation.

Laurer's canal: absent.

It is proposed to present the type specimen to the British Museum (Natural History), when the present work on the Trematoda of Ceylon is completed. The type specimen is retained meanwhile in the Zoological Department of Ceylon University College.

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A New Sawfly from Ceylon (Hym. Tenthredinidae)

BY

R. Malaise

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Through the kindness of Mr. Robert B. Benson, of the British Museum, I have had the opportunity of seeing three specimens of a species of Selandriini sent to him from the Colombo Museum and belonging to the genus *Eusunoxa* Enslin. It proved to be new to science and the description is given here.

Eusunoxa ceylonica, sp. nov.

Reddish yellow ; head including the antennae black with a faint bluish tinge. Apex of saw-sheath and middle of subapical dorsal abdominal segments in ♂, the genitalia and hypopygidium blackish. The four front legs yellow, all tarsi and apex of the middle tibiae and tarsi black. The black colour of the legs partly interspersed with dark brown. Wings hyaline, apex from rear base of stigma lightly infuscated and the extreme base brown. Nervures, costa and stigma dark reddish brown.

Head not punctured, bright shining, strongly narrowed and not carinated behind the eyes. Postocellar area strongly convex, nearly twice as wide as long ; postocellar furrow obsolete ; lateral furrows very deep and hardly converging at all. Interocellar furrow broad. Pentagonal area obsolete, except for two very feebly defined ridges extending forwards from the two posterior ocelli. Supraantennal furrow deep and in the form of an inverted capital " T." Above the base of each antenna is a very small impressed point (the last rest of antennal furrows). Inner margin of eyes slightly converging. Malar space distinct, a little longer than half the diameter of an ocellus. Clypeus truncate or nearly so. Supraclypeal furrow deep and well defined. Labrum short, obtusely rounded. Maxillar palpi normal. Antennae in both sexes shorter than the abdomen, from the sixth joint tapering to both ends, the third joint distinctly longer (ab. 1 1/4) than the fourth. Thorax and abdomen not punctured or striated, shining. Praepectus

distinct. Hind coxae elongated, reaching to the base of the fifth segment and accordingly the femora surpass the apex of the abdomen. Tibiae a little longer than the femora or the tarsi. The hind metatarsus not quite twice as long as the other tarsal joints together, flattened out as in the Nematid genus Croesus and externally with a longitudinal, angulated impression, the inner side consequently convex. Claws with parallel-cleft subapical tooth. When seen from the side the claws accordingly seem to be simple. Nervation of the wings as described by Enslin.[1]

Length : ♂ 5 mm., ♀ 5·5—6·5 mm.

One ♂ (23.V.1929) and 2 ♀ (11.IX.23) from Ceylon (Colombo).

Type ♀ and allotype ♂ returned to the British Museum. Paratype ♀ in the private coll. of the Author.

The genus Eusunoxa, with the hitherto only known species *E. formosana*, was described by Enslin from the Island of Formosa. The long maxillar palpi of that species (they reach nearly to the middle coxae) have evidently only specific and not generic value. The Formosan sp. has the hind metatarsus more than twice as long as the other tarsal joints together ; the third and fourth antennal joints equal ; head strongly punctured and the whole animal of a reddish yellow colour, only the flagellum of the antennae black.

1. (Ein Beitrag zur Tenthrediniden-Fauna Formosas; *Societas entomologica*, Jahrgang 25, Frankfurt a. M., 1911).

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Erratum slip.

The correct pagination of Vol. XVII., Part 3,
is shown in larger figures.

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'*ombo*

ine of *Loris*
tardigradus, which was presented, when alive, to the department by one of my pupils, Mr. C. Lucian de Zylva. The Loris died after about a month in captivity and its small intestine was heavily infested by these Trematodes, which were firmly attached to the intestinal wall. The parasites were preserved in 90 per cent. alcohol; the description and measurements were made from the preserved specimens. I propose the name *Phaneropsolus lakdivensis* for this Trematode. A description of the new species is given below.

Phaneropsolus lakdivensis, sp. nov.

External appearance

It is oval in shape (fig. 1), with a cuticle beset with small, backwardly directed spines. The largest individual measures 0.572 mm. in length and 0.332 mm. in breadth. The broadest region is on a level with the testes. The suckers are large and well developed, with very deep cavities. As the parasites were firmly attached to the intestinal wall, the cavities of the suckers were always filled with its tissues. The oral sucker measures 0.125 mm. in diameter and is situated 0.06 mm. from the ventral sucker, which has a diameter of 0.119 mm.

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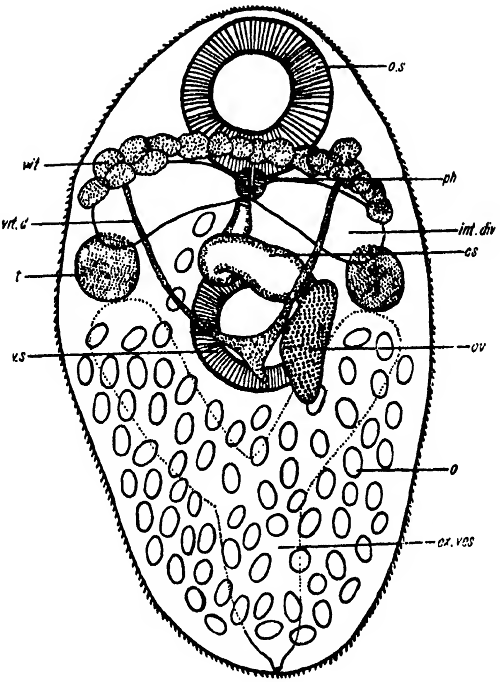

Fig. 1. *Phancropsolus lakdivensis* : dorsal view. × 150.

cs.; cirrus sac; *ex.ves;* excretory vesicle; *int. div.*, intestinal diverticulum; *o.*, eggs in uterus; *o.s.*, oral sucker; *ov.*, ovary, *ph.*, pharynx; *t.*, testis; *v.s.*, ventral sucker; *vit.*, vitellaria; *vit.d.*, viteline duct.

Alimentary canal

The mouth is subterminal; it leads through the cavity of the sucker into a globular pharynx, measuring 0.043 mm. in diameter, which is situated above the posterior end of the oral sucker. The pharynx leads into a very short oesophagus, measuring 0.024 mm. in length and 0.012 mm. in diameter. The intestine bifurcates to form the intestinal diverticula, which measure about 0.151 mm. in diameter in the widest region. The intestinal diverticula extend to about 0.18 mm. from the anterior end of the body, ending directly above the anterior limits of the testes on a line with the anterior region of the ventral sucker.

Excretory system

The excretory pore is postero-dorsal in position. It leads by a narrow passage into the excretory vesicle, which is Y-shaped. The posterior limb is 0.096 mm. long and has a diameter of 0.087 mm. About 0.156 mm. from the posterior end it divides into the two limbs, each of which extends along the side of the body to the posterior limit of the testis, ending in a line slightly in front of the middle of the ventral sucker. Each limb measures 0.087 mm. in diameter.

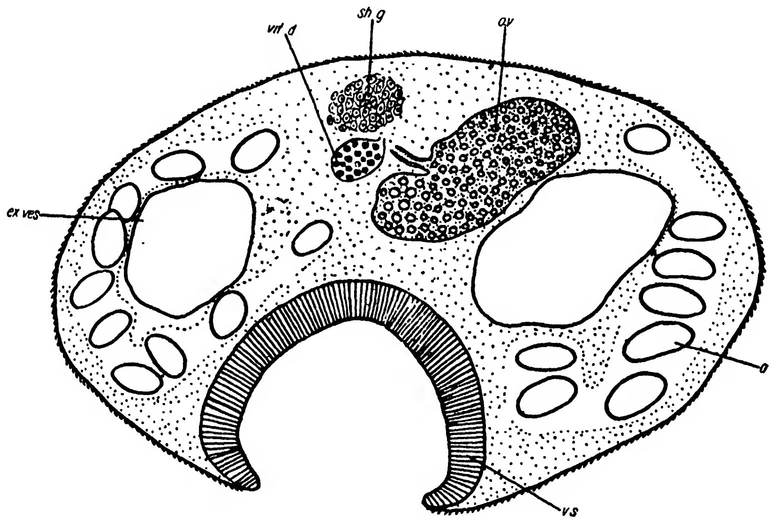

Fig. 2. Section of *P.lakdivensis* passing through the middle region of the ventral sucker.

ex.ves., execretory vesicle; *o.*, eggs in uterus; *ov.*, ovary; *sh.g.*, shell gland; *vit.d.*, vitelline duct; *v.s.*, ventral sucker.

Reproductive system

The testes lie antero-laterally to the ventral sucker, on a level with the anterior region of the ventral sucker, and, as stated above, underneath the posterior ends of the intestinal diverticula. The uterine coils do not extend between the testes. Each testis is round and has a diameter of 0.078 mm. From each testis a vas deferens arises, opening into the vesicula seminalis in front of the ventral sucker. The vesicula seminalis, lying partially above the anterior region of

the ventral sucker, is contained in the long, S-shaped cirrus sac and opens into the well-developed pars prostatica. The latter is bent backwards and downwards, leading by a short cirrus into the genital atrium. The genital pore is situated in the middle line slightly behind the pharynx.

The ovary is elongate and lies as a rule above the ventral sucker to the left side (fig. 2), although in many specimens it lies directly above the ventral sucker. It measures 0.078 mm. by 0.040 mm. A short germiduct leads into the ootype, round which is grouped the shell gland, which lies directly above the ventral sucker. There is neither receptaculum seminis nor Laurer's canal. The vitellaria are situated anteriorly close against the intestinal diverticula. The vitellaria of the two sides meet above the oral sucker (fig. 3). Each vitellarium consists of 7-9 follicles, and from near the centre of each vitellarium there arises a vitelline duct. The two ducts lead posteriorly to unite above the ventral sucker forming the vitelline reservoir. From this reservoir a short vitelline duct arises to open into the ootype. The uterus is much coiled in the posterior region, but its loops could not be made out distinctly. Anteriorly it opens on the right side at the genital atrium.

The eggs measure 0.029 mm. by 0.014 mm.

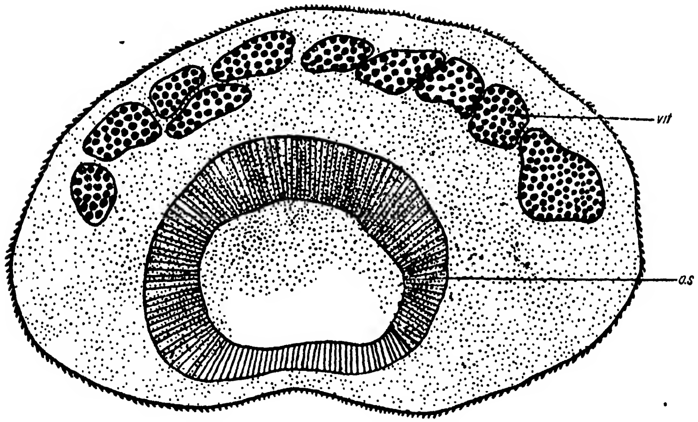

Fig. 3. Section through the posterior region of the oral sucker of *P. lakdivensis*. *os.*, oral sucker; *vit.*, vitellaria.

Relationships of Phaneropsolus lakdivensis

Three species of *Phaneropsolus* have been recorded from the Primates (Nicoll, 1927): *P. longipenis* (Looss, 1899) from an " ape ", *P. oviformis* Poirier (Looss, 1899) from *Nycticebus javanicus* and *P. orbicularis Diesing* (Braun, 1901) from *Nyctipithecus trivirgatus*. The species under description agrees closely with *P. orbicularis*, but differs from it in the following characteristics: it is smaller in size; the oral sucker is larger than the ventral sucker; the pharynx is larger; an oesophagus is present; the testes lie on a level with the anterior border of the ventral sucker; the ovary lies above the ventral sucker and is elongate; a receptaculum seminis is not present, a characteristic of *P. oviformis* about which Looss was sceptical; and the excretory vesicle is distinctly Y-shaped. These characteristics are considered sufficiently diagnostic to create a new species for this parasite.

Diagnostic characters

Host: *Loris tardigradus;* small intestine.

Locality: Ganewatta (N.-W.P., Ceylon).

Size: 0.572 mm. by 0.332 mm.

Cuticle: covered with spines.

Oral sucker: 0.125 mm., deeply concave.

Ventral sucker: 0.119 mm., deeply concave.

Mouth: subterminal.

Pharynx: 0.043 mm.

Oesophagus: very short, 0.024 mm. by 0.012 mm.

Intestinal diverticula: short, extending backwards to a level with the anterior region of the ventral sucker.

Excretory vesicle: Y-shaped, extending anteriorly to the testes.

Testes: round, 0.078 mm.

Cirrus sac: S-shaped; vesicula seminalis single, opens into a long pars prostatica.; cirrus short.

Ovary: elongate; lies above the ventral sucker on the left side or sometimes directly above the ventral sucker; 0.078 mm. by 0.040 mm.

Shell gland: lies above the ventral sucker.

Receptaculum seminis: absent.

Laurer's canal: absent.

Vitellaria: consist of 7-9 follicles on each side; unite above the posterior region of the oral sucker; lie close against the walls of the intestinal diverticula.

Uterus: fills the posterior region; opens anteriorly into the genital atrium.

Eggs: 0.029 mm. by 0.014 mm.

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Descriptions and Records of Ceylonese Acrididae

BY

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(With Nine Plates and One Text Figure.)

The following paper records the results of study of a collection of Acrididae which I took to England on my last furlough in 1930 and worked out at the British Museum (Natural History) with the kind assistance of Dr. B. P. Uvarov; together with a few species, and far more material of others, which have come to hand since my return to Ceylon.

It may not be inappropriate here to indicate a few of the difficulties which beset an isolated entomologist working in the tropics. The first is undoubtedly the difficulty of getting together the necessary literature, much of which is out of print. Secondly, the descriptions of many of the earlier writers leave much to be desired, and examination of the types, impossible in ordinary circumstances to a tropical worker, is the only satisfactory way to settle the identity of species. Thirdly, the lack of exotic material for comparison. Fourthly, the disadvantage of preserving specimens in a hot and humid climate.

With regard to the second item, I wish to point out the severe handicap laid on workers who have not access to types, by the publication of descriptions unaccompanied by figures. The great majority of descriptions of Indian and Ceylonese Acrididae (not to mention other insects) are not illustrated and this fact practically debars entomologists in these countries from identifying their material on the spot with any certainty. In the case of some of the species herein described as new I am not sure that they may not be at most, sub-species of forms already described from the mainland; but as the descriptions are very inadequate, unaccompanied by figures, and the types in some cases lost, it seems that the only reasonable course is to describe the Ceylonese forms as new, giving accurate illustrations, so that future workers may have a more solid foundation for their studies than exists at present. It is hoped that the descriptions and figures herein offered may prove satisfactory for recognition of the species described.

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With regard to the third item it is obvious that, without recourse to the rich accumulations of exotic material in the great museums of Europe, the tropical worker is prevented from paying due regard to the broader affinities of his species and he must content himself with a very circumscribed outlook; paying greater attention to matters of detail than to generalizations—in which he is likely to find himself floundering in a morass should he be tempted to indulge in them.

The fourth item needs no comment. For the benefit of those who collect in similar climates, however, I will briefly indicate the technique which I have found most successful—or perhaps one should say, least unsuccessful!—in preserving Acridians and other Orthoptera in Colombo. After killing in a cyanide bottle, and before the onset of *rigor mortis* or else soon after it has passed off, the insect is eviscerated through a slit cut in the inter-pleural membranes of the proximal three or four abdominal segments—the slit not encroaching on the sternum. This evisceration is best carried out by means of a pair of fine, curved-pointed forceps which should be inserted through the slit and passed forward to grip the crop shortly behind the neck. The crop is then drawn out and usually breaks at the mid-gut. The latter and the hind-gut, and also the ovaries or testes etc., may be removed by a similar process with the forceps passed backwards. The insect is now empty and as the anus will almost certainly have been invaginated in the process of pulling out the hind-gut—dragging in the cerci and other structures with it—it is necessary to restore the position of the parts by inserting, through the abdominal slit, a pin with which they may easily be pushed out to the natural position.

A few drops of 5% formol are now introduced into the body by means of a pipette; this has the effect of fixing the delicate pigment layer and coagulating the muscles etc.—rendering them, incidentally, distasteful to pests such as Phoridae, ants, and Psocidae. The formol should not be allowed to dry inside the specimen, for if it is, the colour will be completely altered and setting and mounting will become impossible. After a minute or so it may be drained off by means of the pipette, or by inserting slips of blotting paper. No 'stuffing' is either necessary or desirable in the case of Acrididae, though Tettigoniidae and some other families require it. The specimen is then ready for pinning, mounting, and drying; with regard to the former I find it better, where the size of the pronotum permits, and especially if the wings are not to be spread, to insert the pin through it near the hinder part, to one side of the middle line; rather than, as is often recommended, through the base of a tegmen; for in

the latter position it is very liable either to displace or break the tegmen, or to obliterate some of the sternal characters. It is generally desirable to spread the wings of one side so that the venation may be readily examined. Where several specimens are available it is always well to pin one or two sideways, through the pleurae, as in this position the ventral and dorsal characters can be better made out than when the pin passes through them.

With regard to pins I use only those made of rustless steel, for direct pinning; and pure silver points on polyporus pith blocks for staging insects under, say, half an inch long (having due regard to the bulkiness or otherwise of the specimens). Ordinary silvered-brass entomological pins are utterly worthless in the humid tropics.

The above-described process may seem too elaborate, but it is easily carried out with a little practice and the results are far more satisfactory than the method of mere pinning and drying—however rapidly the latter is carried out. Unless grasshoppers are properly eviscerated soon after death, their digestive juices remain active, dissolve the walls of the mid-gut, and escaping into the body-cavity, soon discolour and spoil the whole specimen. Unless formol is used as a disinfectant the muscles are apt to decompose, discolouring the specimen and making it offensive. Moreover, small flies of the family Phoridae are very apt to discover such specimens and oviposit in them, the resulting crop of maggots soon reducing them to a disgusting state.

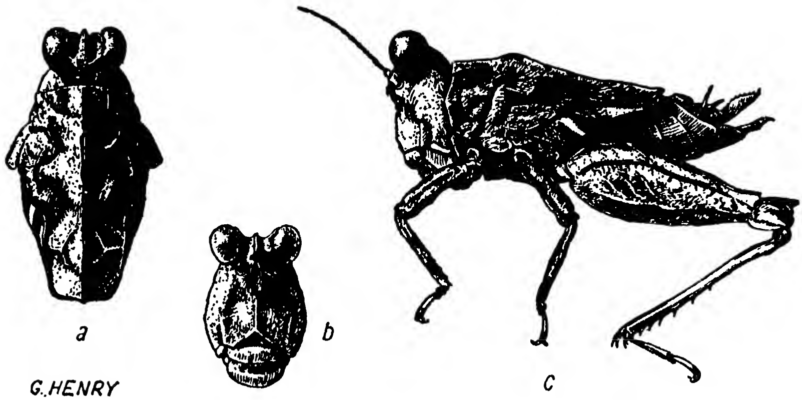
The collections are housed in tight-fitting store boxes, in each of which a little bag of powdered naphthalin and a few drops of carbolic acid on a little wad of cotton-wool pinned in one corner, suffice to protect them from insect pests and moulds.

Sub-family ACRYDIINAE

Amphinotus muscosus, sp. nov.

Male and *female*. Very close to the genotype, *A.pygmaeus* Hancock (1915, p. 96) but differing in the following particulars: Size slightly smaller; vertex much narrower, abcut as wide as the length of an eye viewed dorsally; eyes, in profile, considerably more prominent; pronotum with its median carina much less elevated between the

shoulders, its surface less rugged, its cariniform tubercles less pronounced; the lateral carinae on the hind process less strongly sinuated; the posterior margin instead of being minutely excised medially (as it is in *A. pygmaeus*) is very obtusely angulate.



Amphinotus muscosus sp. nov. ♀

a. Head and pronotum, dorsal view × 7. *b.* Face × 7. *c.* Whole insect, profile × 7.

Coloration. In life, various shades of mottled green variegated with brown. The eye has a transverse equatorial fascia of dark olive across its middle; below this fascia it is sordid yellow, above it is dusky greenish. The dorsum of head bears two yellowish-green lines which arise at the postero-internal margins of orbits and converge backwards to the pronotal margin; these lines are set in the midst of a darker patch. The dorsal carina of pronotum is sordid yellow with about 7 brown spots, of which the second and largest occupies the highest part of the crest. The pronotum bears various pale, greenish-yellow markings of which the most conspicuous are: one on the fore margin of lateral lobes; an oblique line set in a brown patch on the lateral area of posterior process; a broader, less definite line parallel to it, crossing the posterior process obliquely, further back. Some individuals (probably immature) have a large buff patch on the posterior process of the pronotum. The fore and mid femora are crossed by three rows of white spots on their carinae. The hind femora are crossed by three indefinite paler bands, and where these cross the carinae the latter are white. The hind tibiae are pale in their basal third. There is a broad, mottled dark band on the sides of the abdominal tergites.

The specimens are nearly always so dirty that the colour scheme is obscure and I find that they are best examined, soon after death, in a liquid medium such as dilute formalin or petrol, which renders the layer of dirt transparent. In dry specimens, of course, these colours mostly vanish.

Measurements

	4 ♂ mm.	4 ♀ mm.
Length, head and pronotum	3.5 to 3.75	4.5 to 4.75
Width of head, including eyes	1.3 to 1.35	1.5 to 1.55
Length of antenna	2.2 to 2.5	2.2 to 2.4
Length of pronotum	2.75 to 2.9	3.65 to 3.9
Greatest width of pronotum	2.2 to 2.25	2.7 to 2.8
Length of hind femur	3.2 to 3.7	4.0

Material examined. 1 male captured by me, 9-xi-29; 1 female, 25-x-32; 2 males, 3-xii-32; 5 males and 3 females, 9-xii-32; captured by Mr. W. W. A. Phillips; all the specimens were taken at Mousakande Estate, Gammaduwa, *circa* 3000 to 4000 feet. Like *A.pygmaeus* they are found on damp mossy rocks in jungle, and, owing to their coloration, they are hard to distinguish especially as their habit is to remain quiescent until very closely approached, when they ' come to life ' and leap vigorously away. Living examples have been observed to feed on moss.

The type, a female, 9-xii-32, and a series of paratypes will be presented to the British Museum.

This species is closely related to the genotype and may prove to be entitled only to sub-specific rank when the races—if any—inhabiting the montane areas intervening between its habitat and that of *A.pygmaeus* have been collected. Such differences as I have observed, however, are constant and sufficiently marked to enable individuals to be relegated to one or the other with certainty. The figures given herewith are drawn to the same scale as those of *A.pygmaeus* given by Hebard (1932) in this Journal, Vol. XVII, Pt. I, p. 22, and will serve to illustrate the main points of distinction between them.

It may be of interest to point out that Gammaduwa lies amongst the northern spurs of a mountain massif, which is separated from the main (central) massif of Ceylon by the comparatively low-lying Dumbara valley; the rainfall in both montane areas is high, but the Dumbara valley carries with it a strip of ' dry-zone ' which thus augments the isolation of the northern massif. Under these conditions the usual result of geographical isolation—specific divergence in forms of life—must be expected.

Amphinotus pygmaeus Hancock

For comparison with the last, I offer the following measurements of *A.pygmaeus*, of which the Colombo Museum possesses 24 specimens collected at Ohiya, Hakgala, Haputale and Nuwara Eliya (all over (5000 feet).

	4 ♂ mm.	4 ♀ mm.
Length, head and pronotum ...	3.75 to 4.0 ...	4.7 to 5.9
Width of head, including eyes	1.4 to 1.5 ...	1.7
Length of antenna ...	2.1 to 2.2 ...	2.1 to 2.4
Length of pronotum ...	3.0 to 3.4 ...	4.0 to 4.15
Greatest width of pronotum	2.2 to 2.35 ...	2.9 to 3.0
Length of hind femur	3.6 to 3.7 ...	4.0 to 4.55

Sub-family ACRIDINAE

Pasiphimus sagittaeformis Bolivar (1914, p. 103)

The Colombo Museum possesses a series of 6 males and 2 females which I identify from description as this species. They were taken at the following places and dates: 1 female, near Bibile, in park country, 19-vii-29; 4 males, at ninth mile on Bandarawela-Welimada road, 4-iv-31; 1 female, Bandarawela, 10-iv-31; 1 male in the last larval instar, Wellawaya, 28-iv-31; 1 male, Bandarawela, -viii-32 (presented by O. S. Wickwar, Esqr.)

Measurements

	♂ mm.	Bibile ♀ mm.	Bandarawela ♀ mm.
Length	18.5 to 19.0	25.5	24.1
Length of antenna ...	10.5 to 11.0	10.5	9.5
Width of head including eyes ...	1.5 to 1.6	2.1	1.8
Length of pronotum ...	2.5 to 2.6	3.5	3.0
Length of tegmen ...	17.5 to 19.5	25.5	21.6
Breadth of tegmen ...	1.2	1.7	1.7
Length of wing	13.5 to 14.2	?	14.2
Length of hind femur ...	7.5 to 8.4	10.0	9.0

Two males will be presented to the British Museum (Natural History) on publication of this paper.

Zygophlaeoba bolivari, sp. nov.

Plate XXVIII, figs. 1 and 2

Female; (male unknown). Antennae about as long as the head, flattened, carinate beneath, segments 3 to 6 broad, 7 narrower, 8 and 9 narrower still, the remainder, of 3 or 4 joints (the exact number is a matter of doubt) forming a nearly cylindrical, apically pointed, club. The segments are almost squarely truncate distally, and their relative lengths vary to some extent in different specimens.

Fastigium of vertex rounded in front, with a small median carinula, separated from occiput by a parabolic sulcus. Median carina of occiput extending from this sulcus to the pronotal margin, its lateral carinae becoming broken and indistinct before reaching the level of the hinder margin of the eyes.

Frontal ridge rather deeply sulcate from the level of the antennal insertions downwards, rugulose, its sides gently convergent until above the median ocellus, then diverging evenly to the clypeus. In profile it is nearly straight with a slight sinuosity above the ocellus. Face obscurely rugulose everywhere.

Pronotum roundedly truncate in front, more straightly truncate behind, with a small median emargination in the hind border. Median and lateral carinae well developed, the latter nearly straight and parallel. (In one of the Wirawila specimens the lateral carinae are much more strongly developed than in the others.) The sulci are very fine, the hinder one alone cutting the median carina. The surface of the pronotum is somewhat coarsely rugulose and punctured.

Tegmina broadly lanceolate, reaching in different individuals from a little beyond the base of the second tergite to nearly its distal margin. Wings are present.

The meta-thoracic epimera are expanded outwards so that their distal surfaces face obliquely upwards. There is a strong oblique carina on the metepisternum and the pleurae generally are punctured and rugulose like the pronotum. The metanotum and the abdomen are strongly medially carinate but they have no lateral carinae. The abdomen is closely but obsolescently punctured throughout. The supra-anal plate is roundedly pointed, medially shallowly sulcate in the basal half. The valves of the ovipositor are short, stout and unarmed (in one specimen very much worn down).

The fore legs are much shorter than the mid legs, their femora with two well-marked dorsal, and some obsolescent, lateral carinae. The mid-femora bear strong dorsal and ventral carinae, and two on the outer face. The posterior femora have their dorsal and ventral carinae fairly strong, the former terminating distally in a minute tubercle. The posterior tibiae bear 10 outer and 11 inner spines which are evenly graduated in size.

Coloration. Pale brown in ground colour, faintly mottled and marbled with darker brown and with small black dots. The metepimera have a pale, well-defined triangle at their apices. One

specimen (from Bintenna) has a buff-coloured dorsal fascia occupying the dorsum of antennae and head, pronotum between the lateral carinae, inner area of the tegmina, and the meso- and meta-nota etc.

Measurements

	♀
	mm. mm.
Length of body	21.0 to 22.0
Length of antenna ...	3.8 to 4.3
Width of antenna ...	0.7 to 0.75
Length of pronotum ...	3.5 to 3.8
Width of body at metepisternum	4.4 to 4.75
Length of tegmen ...	3.5 to 4.0
Length of hind femur ...	10.5 to 11.5
Breadth of hind femur ...	3.0

Material examined. 3 females from Wirawila, Southern Province, 26-vii-21; 1 female from Bintenna -x-28; 1 female (type) from Bibile, 19-vii-29. The type and a paratype will be presented to the British Museum on publication of this paper.

Remarks. This species is obviously very close to *Z.collina* Uvarov (1929, p. 539) from South India, but Dr. Uvarov has seen the specimens and considers them distinct. The form of the fastigium and of the pronotum suffice to separate the two forms, but it is unfortunate that the male of the new species is unknown.

I have pleasure in naming this insect in honour of Dr. Ignacio Bolivar who has done so much to extend our knowledge of Indian and Ceylonese Acrididae.

Zygophlaeoba varicornis, sp. nov.

Plate XXVIII, figs. 3, 4, and 5

Male. Antennae about as long as the head, flattened above, carinate below, segments 3 and 4 (each of which appears to be formed by the fusion of two or more segments) occupying fully a third of the flagellum, and broader than the rest. Segments 5 and 6 are about equal in breadth, 7 narrowest, 8 a little broader, the remaining 4 or 5 segments forming a long-oval club in which the segment divisions are indistinct. (There is considerable individual variation in the proportions and size of the segments in the specimens before me and I do not regard precise antennal characters in this genus as of very high importance.)

Fastigium of vertex much as in the last species (*Z.bolivari*) but relatively broader, and the median and lateral carinae more pronounced.

Face in profile reclinate emarginate above the median ocellus, otherwise gently convex; its surface is uneven, but hardly rugulose. Frontal ridge deeply sulcate with its sides nearly parallel above the ocellus, gently divergent below it. Lateral carinae strongly developed.

Pronotum gently rounded in front, obtuse-angularly excavated behind, the median and lateral carinae well-marked, the latter almost straight and parallel. The transverse sulci are feeble, only the hinder one cutting the median carina. The surface of the pronotum is feebly and irregularly punctured almost everywhere; the sculpturing is more pronounced in some individuals than in others.

The tegmina are lateral and reach about to the hind margin of the first abdominal tergite, covering the auditory tympana. They are rounded at the tip and slightly broader distally than at the base.

The metathoracic epimera are relatively smaller and less conspicuous than in *Z.bolivari.* The metanotum and abdomen are medially carinate but less strongly so than in the latter. There are low dorso-lateral carinae on the metanotum and the first two or three abdominal tergites, gradually becoming obsolescent posteriorly. The rugae between these carinae and the median one are fairly strong and tend to take a longitudinal direction.

The limbs resemble those of *Z.bolivari*, but the hind femora are relatively shorter and stouter, and the hind tibiae bear 9 or 10 outer and 9 inner spines.

Female. The female resembles the male in most features but is of course larger and has a less reclinate face. Her genitalia resemble those of *Z.bolivari* but the supra-anal plate is rather shorter and broader.

Coloration. Most of the specimens before me are of various shades of brown, slightly mottled and marbled with darker brown and with scattered small black spots. Several individuals however have a broad dorsal fascia of ochraceous involving the dorsum of antennae, upper part of head, pronotum between the lateral carinae, inner portion of tegmina, dorsum of meso- and meta-thoraces and abdomen. Some specimens of either sex have a transverse, dark-brown fascia on the metazona of the pronotum, extending between the lateral carinae.

Measurements

	♂ mm.	♀ mm.
Length of body	12.3 to 13.5 ...	18.0 to 20.0
Length of antenna	3.1 to 3.9 ...	3.3 to 4.0
Width of antenna	0.35 to 0.5 ...	0.5 to 0.6
Length of pronotum (along dorsal carina)	2.1 to 2.3 ...	3.0 to 3.4
Width of body at metepisternum ...	3.0 to 3.2 ...	4.4 to 4.75
Length of tegmen	2.0 to 2.1 ...	2.8 to 3.0
Length of hind femur ...	6.7 to 7.7 ...	8.6 to 10.0
Breadth of hind femur ...	2.0 to 2.3 ...	2.8 to 3.0

Material examined. Type and 4 other males and 12 females from Kantalai, Eastern Province, 16-vii-27 and 20-iv-31; 2 males and 8 females from Trincomalee, 11 to 14-vii-27 and 21 and 22-iv-31; 1 male

from Mihintale, 7 to 9-vii-27; 1 male from Kalkudah, third mile on Trincomalee road, 24-iv-31; 1 female, Elephant Pass, 6-i-23; 1 female, Horawupotana, 14-x-24; 1 male and 2 female larvae from Vavuniya, 16 to 22-xii-23; 1 female larva from Wellawaya, 28-iv-31. It is probably very generally distributed throughout the low-country forests of the dry zone. The type and a series of paratypes will be presented to the British Museum (Natural History); the remaining paratypes are retained in the Colombo Museum. All the specimens were taken on the ground among dry leaves on jungle roadsides and similar situations.

This species differs from the last in its smaller size, pronotal structure, shape of tegmina, and in the presence of a dorso-lateral carina on the metathorax and proximal abdominal segments. It is very possible that it may be, at most, an insular race of *Z.sinuatocollis* Bolivar (1902, p. 591), with the very inadequate description of which it agrees fairly closely, but as that species was described, without any figure, from a unique male—which is lost—and the precise type locality is not indicated, it seems preferable to risk the dangers of synonymy rather than the worse ones of confusing possibly distinct species under one name. It is much to be hoped that South Indian entomologists will pay special attention to this genus in the future by collecting an extensive series of specimens throughout its range so that the relationships of the five Indian and two Ceylonese species hitherto described may be accurately determined.

Bababuddinia dimorpha, sp. nov.

Plate XXIX, figs. 1 to 4

Male. Antennae reaching nearly or quite to the posterior margin of pronotum, segments 2 to 7 slightly broadened and flattened above, the remainder more oval in section, the apical ones becoming slightly broader. Eyes broadly oval with the anterior margin less strongly curved than the posterior.

Fastigium of vertex much as in *Zygophlaeoba varicornis* but not so produced in front, with no trace of a median carina, and with the foveolar impressions not extending so far in front. Its surface is smooth, rather deeply concave, with thickened and raised edges which, as carinulae, pass backwards down the occiput, converging slightly between the fore part of the eyes, then parallel and gradually becoming irregular and obsolescent behind. Within these carinulae the fastigium is separated from the vertex by a semicircular sulcus, behind which there is a small median irregular carinula. Occiput rugulose.

Face rather strongly reclinate; coarsely, callously rugose. Frontal ridge in profile meeting the fastigium in a broadly rounded angle, its outline very gently curved with a slight sinuosity above the median

ocellus; it is sulcate and punctured from a point between the antennae, its carinae gently diverging except just above the ocellus where they are very slightly curved inwards for a short distance.

Pronotum gently rounded in front, rather unevenly rounded behind; its surface coarsely rugulose; the median carina is moderately developed, the lateral carinae are gently curved inwards. The transverse sulci are fine, the principal one cutting the median carina at about the third fifth from the front margin. The pleurae are shallowly punctured.

Tegmina extending nearly to the end of abdomen (at least, in the two males before me), narrow, rounded at the tip, slightly expanded in the basal third of the costal area; there is a narrow hiatus between them at the base in the folded condition. The wings reach nearly or quite to the ends of the tegmina.

Metasternal lobes contiguous. (See Plate XXIX, fig. 4).

Legs very similar to those of *Zygophlaeoba*. Hind femora projecting well beyond the apex of abdomen, their dorsal carina terminating distally in a minute spinule. Hind tibiae with 9 external and 10 internal spines.

Abdomen obsolescently punctured throughout.

Female. The female resembles the male in most respects but is considerably larger, with eyes less prominent and more triangular, face less reclinate, fastigium much broader, with the occipital median carinula almost obsolete. The series of five females before me shows that brachypterous forms exist and in these the hinder border of the pronotum is almost truncate, whereas in the ordinary form it is slightly more produced. The tegmina in the brachypterous specimens are strongly tapered distally and extend to the middle or posterior margin of the third abdominal tergite; in the macropterous form they are shaped like those of the male and extend to about the end of the eighth. Apart from these differences the two forms are identical and I have no doubt that they are conspecific.

The metasternal lobes in the female are briefly separated.

The valves of the ovipositor are short and unarmed, the lower pair only slightly shorter than the upper.

Coloration. Ochreous brown to deeper brown (more greyish in life). In three of the females before me (two macropterous and one brachypterous) there is a well-marked dark-brown fascia on the side of the pronotum just below the lateral carina, which forms its dorsal border; its ventral border is obtusely emarginate (see Plate XXIX, fig. 2). In the other two females (one macropterous and one brachypterous), and the two males, this mark is paler and undefined below. In one macropterous female there is a broad, transverse, dark-brown fascia on

the metazona shortly behind the principal sulcus; the area covered by it being slightly depressed and smooth. The projecting lobe of the metepimeron is pale, bordered on the inner side by a dark area. The tegmina are variable in colour but tend to be dark-brown in the mediastinal and scapular areas, paler in the remainder; one female has a pale stramineous stripe along the scapular vein. The wings are yellowish hyaline slightly infumated towards the apex, their veins yellowish proximally, dark-brown distally.

Measurements

	♂ mm.	♀ mm.
Length of body	18.0 to 19.0 ...	25.0 to 29.0
Length of antenna	6.0 to 6.2 ...	6.0 to 6.5
Width between eyes, above ...	0.9 ...	1.2 to 1.25
Length of pronotum	3.7 to 3.8 ...	5.0 to 5.2
Length of tegmen	11.0 to 11.5 ...	7.3 to 16.0
Length of hind femur ...	11.5 to 12.0 ...	15.0 to 15.5
Breadth of hind femur ...	3.1 to 3.2 ...	3.75 to 4.0

Material examined. Type and another male and 3 macropterous females captured at Kantalai, Eastern Province, on 16-vii-27; 2 brachypterous females taken at Mihintale, 7 to 9-vii-27. All were taken on the ground, amongst dead leaves, in shady jungle without much undergrowth. The type and two paratype females will be presented to the British Museum (Natural History).

This species appears to be very closely allied to *B. bizonata* Bol. (1918, p. 382) of which it may be an insular race. It is somewhat larger than Bolivar's species however, and Dr. Uvarov, who has kindly examined the specimens, considers them distinct.

Sub-family OEDIPODINAE

Scintharista marshalli, sp. nov.

Plate XXIX, figs. 5, 6, and 7

Male. Antenna about reaching the hind margin of the metanotum. Eyes broadly oval, their long axis nearly vertical, hinder margin of orbit more strongly curved than the fore margin. Fastigium of vertex very indistinctly demarcated from the occiput, with which and the facial scutellum it forms, in profile, a single curve slightly bulged between the antennae. Its surface is nearly flat, as broad as long, separated from the facial scutellum only by an obsolescent transverse carinula. There is a short trace of a median carinula at its occipital margin. The temporal foveolae are small and ill-defined.

The frontal ridge is slightly widened between the antennae, parallel-sided until shortly above the clypeus where its margins diverge slightly and become obsolete. Its surface is rugoso-punctate and scarcely concave above the ocellus, broadly sulcate immediately below it.

The occiput and upper portion of the genae are smooth, remainder of head sparsely rugose.

The pronotum has the median carina well developed, deeply cut by the principal sulcus at about the third seventh from the front. Its posterior margin forms slightly more than a right-angle, extreme apex rounded. Lateral lobes deep, their fore and hind margins almost parallel, their ventral margin obtuse-angled in front, broadly and somewhat truncately rounded behind. (See Plate XXIX, fig. 6). The disc of the pronotum is opaque, rugged, and set with small tubercles; the lower half of sides of prozona is slightly shiny and rugose, and the sides of the metazona, from the shoulders downwards are closely punctured.

The meso- and meta-pleurae are closely rugoso-punctate. At the antero-lateral borders of the mesosternum there are patches of irregular puncturation which are separated from the puncturation of the meso-pleurae by smooth callosities. The mesosternal lobes are as wide at the fore-margin as their interspace, their postero-internal margins obtusely rounded. The metasternal interspace is narrower than the mesosternal, transversely oval in shape.

The tegmina extend as far as the proximal third (type) or half (paratype) of the extended hind tibiae. Their basal half is coriaceous, nearly half of the remainder sub-coriaceous with irregular reticulation, the apical third being hyaline with rather regular reticulation. The basal two-thirds are reddish-brown, crossed by a broad, indefinite, pale fascia at the proximal third and another, narrower one (very indistinct in the paratype) just beyond the middle of the tegmen. There are irregular brown spots along the branches of the radial and median veins and a row of similar spots at the postero-dorsal margin. There is an irregular cluster of spots forming a sub-apical patch. (N.B.—All these markings are better defined in the type than in the paratype, which is probably somewhat teneral.)

The wings are crossed at about their middle or a little beyond it by a broad smoky fascia, which curves inwards along the hind margin but fades out before reaching the inner margin. Within this fascia the wing membrane and veins are lemon yellow, beyond it, the veins are black and the membrane hyaline, with a more or less diffuse apical smoky patch. (See Plate XXIX, fig. 7 which represents the alary organs of the type.)

The hind femora considerably surpass the apex of abdomen.

Coloration. Reddish brown, marbled with black and grey; the ventral parts ochreous yellow. Meso- and meta-sternal sutures black. Meta-notum and base of abdomen dorsally, dark bluish-green. Remainder of abdominal tergites brownish ochraceous, darker dorsally,

with short, black longitudinal lines and brown mottlings near their ventral margins. Fore and mid legs brown, marbled with black. Hind femora externally reddish brown for their proximal five-sevenths, this portion being crossed by three rather ill-defined black fasciae; a sub-terminal annulation of brownish ochraceous; knees black. The inner surface of the femora, from base to the sub-apical pale annulation is deep indigo blue.

The posterior tibiae are proximally black, then annulated with pale brownish-white, their distal five-sevenths being bright crimson suffused with purple proximally; their spines are crimson, black tipped. The hind tarsi are crimson.

Vestiture. The insect as a whole is not hirsute, having merely a little short pilosity on the limbs, mouthparts, lower margin of pronotum, meso- and meta-sterna and pleurae and about the abdominal apex, with a few scattered small setae elsewhere.

Measurements	Type ♂ mm.	Paratype ♂ mm.
Length	28·5	27·75
Length of antenna	12·5	13·0
Width between eyes, dorsal	1·75	1·6
Length of eye	2·8	2·6
Length of pronotum	6·4	6·0
Depth of pronotum	7·1	6·5
Length of tegmen	29·0	28·0
Width of tegmen	6·0	6·0
Length of wing	26·0	26·0
Width of wing	14·0	13·3
Length of hind femur	17·0	14·9
Breadth of hind femur	4·8	4·3

Material examined. Type male captured at Bandarawela, 7-iv-31; paratype male taken at the same place on 11-iv-31. They were captured near the golf links on a rounded, treeless hill, at an elevation of about 4,000 feet, on stony ground with tufts of short patana grass and other herbage. Their appearance was extremely like *Pternoscirta cinctifemur* for which they were mistaken until, in flight, the yellow and black-banded wings undeceived me. The species is evidently not common, as much fruitless search was made for further specimens in the same and similar localities. The type will be presented to the British Museum (Natural History) and the paratype is retained in the Colombo Museum.

The species is named in honour of Sir Guy Marshall, C.M.G., D.Sc., F.R.S., to whose genial assistance I am greatly indebted.

Dr. Uvarov, to whom the paratype was submitted, informs me *in epistola*, that the new species " is similar to *S. notabilis brunneri* Sauss., but differs as follows: Somewhat larger; frontal ridge coarsely punctured; pronotum rugose with the median carina convex in profile;

elytra with irregular reticulation in half of the apical part; wing fascia, broader and the apical spot diffuse[1]; hind tibiae sanguineous (sometimes only slightly reddish in *brunneri*)."

Sub-family PYRGOMORPHINAE

Rakwana [2] gen. nov.

Size medium, form rather slender, cylindrical, completely apterous in both sexes. Antennae long, slender, the flagellum of uniform thickness throughout; cylindrical, except the tip, which is feebly compressed, and the basal four or five joints, which are somewhat triangular in section. Eyes very large, rounded and prominent; median ocellus obsolescent. Head long and narrow, face strongly reclinate and deeply concave in profile, with the frontal ridge almost obsolete in its lower two-thirds, narrow and sulcated, strongly compressed between the antennae. Lateral carinae obsolescent. Vertex declivous in front of the eyes, slightly medially carinate. Foveolae in form of porrect lobes, facing upwards and inwards, separated by a deep sulcus.

Pronotum in section semi-cylindrical, rounded in front, broadly emarginate behind, median margin in both cases slightly excised. Median and lateral carinae completely absent. Three wide but shallow transverse sulci, of which the anterior is interrupted in the middle. Lateral lobes with anterior angle obtuse, posterior rounded. Prosternal tubercle in form of a simple, cylindrical, acute cone.

Meso- and meta-sternal lobes rounded. Their form is best conveyed by the figure (Plate XXX, fig. 4) which represents the female condition. In the male, the metasternal interspace is considerably narrower.

Margin of mesonotum broadly and shallowly emarginate; margin of metanotum roundly convex at each side, emarginate in the middle; margin of first abdominal tergite obliquely truncate laterally, deeply emarginate medially. These features are all rather more pronounced in the female than in the male. There is a slight trace of a median carina, extending along the meso- and meta-thoraces and abdomen.

Auditory tympanum absent. Abdomen not conspicuously tapering, slightly compressed. Genitalia of both sexes resembling in structure those of *Orthacris*.

Fore and mid-legs moderately stout, their femora and tibiae nearly cylindrical. Hind femora rather long and slender, their dorsal carina not spinously produced distally, genicular lobes short, bluntly pointed. Hind tibial spines short, a minute outer apical one present. Hind tarsi rather long, the third joint nearly as long as the other two together.

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1 N.B.—It is much more pronounced in the type specimen, which Dr. Uvarov has not seen.

2 Named from the type locality, Rakwana in the Sabaragamuwa Province of Ceylon.

Genotype: *Rakwana ornata*, sp. nov. described below.

This genus appears to belong to the Section Orthacres and to be not very far from *Orthacris*. It is easily distinguished however, by the form of the antennae, shape of head and especially the vertex, prominent eyes, coarser sculpturing etc.

Rakwana ornata, sp. nov.

Plate XXX, figs. 1 to 4

Male and *female*. Face and genae coarsely rugoso-punctate. Fastigium, vertex, and a broad, ill-defined band on each side of occiput from inner margin of eyes, more finely punctured. Pale-coloured callosities are present on the lower margin of face, along the position of the (obsolete) lateral carinae, and at anterior, inner, dorsal margin of orbits.

Pronotum coarsely rugoso-punctate almost throughout, with pale yellow callosities at the sides of front margin, at anterior and posterior angles of lateral lobes and at each side of hind margin, as well as some large ones in lower part of lateral lobes. These callosites are better developed in the female than in the male.

Pleurae, meso-and meta-nota and first abdominal tergite coarsely punctured; remaining tergites more shallowly punctured, the punctures tending to run into transverse sulci. Hind tibiae armed with 7 to 10 outer spines including a small apical one, and 9 to 11 inner.

Coloration. Sexes similar; general ground colour maroon red. Terminal five or six, and basal three and half of fourth, flagellar segments of the antennae dull orange, the remainder fuscous. The two proximal segments of antennae, region of head in front of eyes, occipital carina, all margins of pronotum (except the yellow callosities mentioned above), and a broad dorsal undefined band, extending the whole length of the thorax and abdomen, olive green. Maxillary and labial palps dirty green, rest of mouth parts nearly black. Fore and mid legs and prosternum dirty green, also the hind femora except the knees which are greenish black. Hind tibiae dark greenish blue, greener proximally, blue-black at base.

A broad, lateral bluish-black band running the whole length of the abdomen. In the female this black band is bordered below by a narrow, bright yellow band along the ventral margins of the tergites. This is absent in the male. Sternites greenish black.

Measurements

	♂ mm.	♀ mm.
Length of body	22.5	28.0 to 31.0
Length of antenna	15.0	16.0 to 17.0
Length of pronotum	3.7	4.5 to 5.0
Length of hind femur	12.5	14.0 to 15.2
Width of head, including eyes	3.75	4.2 to 4.5
Width of head behind eyes	2.1	2.9 to 3.0
Width of inter-ocular space	0.75	1.2 to 1.3
Width of pronotum	2.7	4.0

Material examined. Type male, Rakwana, 2-v-29; 2 female paratypes, Rakwana, 6-v-29; 1 female paratype, Kitulgala, 8-iv-27; also a female larva, Rakwana, 4-v-29.

The type male and a female paratype will be deposited in the British Museum (Natural History) on publication of this paper; the remaining specimens are in the Colombo Museum collection.

All the specimens were taken in heavy jungle, and were hard to catch owing to their powerful and accurate jumping powers and alertness. It is probably not uncommon in the leech-infested jungles of the wet zone.

Sub-family CATANTOPINAE

Tarbaleus crassibrachiatus, sp. nov.

Plate XXXI, figs. 1 and 2

Male; (female unknown). Head broad, face nearly vertical. Fastigium of vertex strongly deflexed, separated from vertex by a broad transverse sulcus. It is broader than long, rounded into the frontal ridge, irregularly pitted on each side of the middle line which forms an indefinite carina. The vertex and occiput obsoletely rugoso-punctate, and irregularly medially carinate, the carina terminating anteriorly in a slight gibbosity between the eyes. The eyes are separated by a space about 1½ times the width of the first antennal joint. The facial ridge is broad, ill-defined on the sides; above the ocellus it is irregularly punctured, below it is broadly and shallowly sulcate. The face and genae are very uneven and are coarsely and irregularly punctured. The antennae are long, slender, cylindrical and of almost even width throughout their flagella; they reach to about the end of the second abdominal tergite.

The pronotum is short, with its front margin very slightly produced and concavely truncate in the middle; the hind margin is very slightly and evenly curved. The chief feature of the pronotum is the rugged appearance caused by the very deep and broad transverse sulci, all of which cross the dorsum. Its puncturation is sparse and obsolescent except on the lower part of the lateral lobes and on the narrow metazona where it is close and irregular. The lateral lobes are coarsely sculptured, their anterior angles fairly well-marked and obtuse, their hinder margins somewhat angularly rounded.

The prosternal lobe is a simple, rounded hump, scarcely at all compressed.

The rim of the acetabulum of the mid legs is strongly produced outwardly; the pleurae are sparsely and obsolescently punctured; the mesepimeron and metepisternum are strongly gibbose. The meso- and

meta-nota are separated by a deep and wide sulcus; the former is transversely shallowly sulcate while the latter is roundedly humped; with the abdominal tergites they are obsolescently punctured. The auditory organ is represented by a small, vestigial tympanum just behind the first abdominal spiracle.

The meso- and meta-sterna are represented in Plate XXXI, fig. 2.

The fore and mid femora (especially the former) are very stout and somewhat flattened, their surface rugged; their tibiae and tarsi are short and broad. The mid coxae bear dorsally a stout, rounded tooth. The hind femora are considerably shorter than the abdomen, rather stout in dorsal view but narrow in profile, their margins smooth, the carinae not well marked. The hind tibiae bear 8 or 9 outer spines (including an apical one) and 8 inner. The hind tarsi have the first and second joints almost equal, the third, with its empodium, very slightly the longest.

The supra-anal plate is longer than broad, triangular with the apex rounded; the cerci are fairly long, tapering, cylindrical, extending just beyond the supra-anal plate.

Coloration. In life this was a beautiful but almost indescribable *mélange* of subdued greys, browns and chocolate, mottled with indefinite spots of dark bluish green on the head and limbs; the antennae are dark olivaceous, annulated with paler green. The sides of the abdominal tergites have a broad irregular fascia of dark bluish green. There is a buff spot on the postero-lateral areas of the mesonotum and marginal fasciae of the same colour on the anterior five abdominal tergites, which unite with lateral spots above the green fascia above mentioned. The hind femora are pale buff in ground colour with chocolate-red on the externo-ventral area. They are partially annulated with two broad, uneven-margined black bands, the first with its centre at about the proximal fourth, the second, which merges with the dark-green and chocolate-red knees, having its centre at about the distal third. The ventral (flexor) surface is deep green. The posterior tibiae are dark olivaceous proximally, black distally, with no pale annulation. The hind tarsi are dark, reddish brown.

Vestiture. The whole insect is smooth and moderately shining. It bears rather long setae sparsely almost everywhere but more numerously on the fastigium of vertex, mouthparts, dorsal and ventral margins of fore and mid limbs, prosternal tubercle, margins of meso- and meta-sterna, venter of abdomen (especially on the three or four distal sternites, which bear conspicuous, longitudinal, ventro-lateral tufts of soft, silky setae), and on the genitalia. The ventral carinae of the hind femora are closely, the others sparsely, setose, and the outer and inner

sides of the hind tibiae and tarsi are densely clothed with long soft pubescence. All the setae are stramineous except those on the inner side of the hind tibiae and tarsi, which are black.

Measurements

	♂ mm.
Length of body	35.0
Width of head	6.8
Length of antenna, about	18.0
Length of pronotum	5.0
Length of fore femur	5.4
Breadth of fore femur...	2.1
Length of hind femur	17.0
Breadth of hind femur...	3.0
Length of hind tibia	16.0
Length of hind tarsus, about	10.0

Material examined. Unfortunately, the type male is the only specimen at present available for study. It was captured in jungle at Labugama on 17-vi-32, and will be deposited in the British Museum (Natural History). Like most Enthymiae, it was a prodigiously powerful jumper.

Remarks. This species differs from the other Ceylonese forms (which alone I have seen) of the same genus in being larger, with longer and more slender antennae; in the gibbous nature of the pleurae and somewhat humped metanotum; and especially in the very incrassate fore and mid legs, and in the coloration.

Tarbaleus gammaduensis, sp. nov.

Plate XXXI, figs. 3 and 4

Of about the size of *T.cingalensis* Kirby (1914, p. 201) but not so stoutly built. Head, as in *T.gracilis* Uvarov (1927, p. 101), somewhat reclinate, but the body is not compressed as in that species and it is smooth and shining with the puncturation obsolescent. It further resembles the last-named species in the form of the prosternal tubercle and the hind tarsi.

Male. Antennae reaching to about the meso-metanotal suture, nearly cylindrical. Face rather strongly reclinate, rather closely punctured; frontal ridge obsolescent below the ocellus, well defined above it, its surface punctured, with smooth, slightly raised margins which are constricted just below the fastigium. The latter is broader than long, finely rugose, medially sulcate, and separated from the occiput by a broad, transverse furrow. The eyes are separated by a

space a little wider than the second antennal joint. The occiput is rather closely but obsolescently punctured and has a trace of a median carina.

The pronotum is sub-cylindrical, slightly produced and very slightly emarginate in front, truncate and not at all produced behind. Four transverse sulci are very well marked, deep and broad, the spaces between them roundedly raised. As in other Ceylonese species of the genus there is a fine, median impressed line in place of the median carina. The sub-marginal areas all round are finely and shallowly punctured but discally the pronotum is practically impunctate. The lateral lobes have their fore and hind angles roundedly obtuse, the lower margin somewhat oblique and nearly straight.

The prosternal tubercle is rather strongly compressed and bi-lobed—the front lobe being bluntly pointed, the hinder semi-circular in profile. The mesosternal lobes are roundedly angular and nearly meet each other, the metasternal lobes are contiguous. The pleurae are rather closely and evenly punctured. The meso- and meta-nota are evenly rounded, finely obsolescently punctured, and separated from each other by a deep and broad sulcus; a less pronounced sulcus separates the metanotum from the first abdominal tergite. The auditory tympanum is absent. There is a very fine impressed medial line on the meso- and meta-nota and the abdomen; the latter is slightly recurved, obsolescently punctured throughout. The supra-anal plate is not quite twice as long as broad, broadly and shallowly sulcate medially and crossed before the middle by a fine step-like ridge. The cerci are short and conical.

Fore and mid femora nearly cylindrical and with fine obsolescent punctures. Hind femora somewhat compressed, rather slender, the carinae not well-marked. Hind tibiae with 9 external and 11 internal spines which are set rather irregularly. Hind tarsus comparatively short, with the second joint much shorter than the first, third distinctly longest.

Coloration. Bright green in life, with the hind tibiae, tarsi and a narrow distal rim to the hind femora dull crimson. The lower part of the labrum is purplish pink, the antennae are reddish brown with pale annulations at the distal margins of the segments, and the eyes are purplish grey, merging all round the edges into pale stramineous.

Female. The female is much larger than the male and has a smoother contour but resembles him in most features; her face is less reclinate, the pronotal sulci are fine and shallow with their interspaces flattened. The posterior lobe of the prosternal tubercle is more produced than in the male.

The supra-anal plate is of the same form as that of the male but somewhat longer, the cerci are very short, the valves of the ovipositor are rather slender, without teeth, projecting beyond the supra-anal plate by nearly half their length.

The female is bright green as in the male; in some specimens there is an indefinite brownish dorsal fascia throughout the length of the body. Her hind tibiae are green for most of their length, changing gradually to red distally.

Measurements	♂ mm.	♀ mm.
Length of body	32.0	46.0 to 47.5
Width of head	5.3 to 5.5	6.7 to 7.0
Length of antenna	10.5 to 11.0	12.2 to 14.0
Length of pronotum	5.5 to 5.7	7.3 to 8.0
Width of body at metathorax ...	5.5 to 5.6	8.0 to 9.0
Length of hind femur... ...	16.0	20.0 to 21.5
Breadth of hind femur ...	3.2	4.2 to 4.7
Length of hind tibia	14.5	18.5 to 19.0
Length of hind tarsus, approx. ...	6.3	8.0 to 8.5

Material examined. Twelve males and 18 females captured by Mr. W. W. A. Phillips at Mousakande Estate, Gammaduwa, at an elevation of about 3500 feet on various dates between 20-iv-32 and 24-x-32, and presented by him to the Colombo Museum. From this material I select as type a well-preserved male taken on 24-x-32. In addition, two males and two females are at present alive in my laboratory where they have survived for over a month. The type and a series of paratypes will be presented to the British Museum (Natural History).

Having been with Mr. Phillips on one occasion when a few of these insects were captured I am able to offer the following remarks on their ecology. They were found in the foliage of certain low, jungle trees growing on the edge of a small 'patana' or patch of grass-land, surrounded by damp jungle, and were easily disturbed at our approach, when they would jump or drop to the ground. They are powerful jumpers but like other Euthymiae that I have observed, seemed inclined, after the first vigorous hop, to sham death in the hope of eluding pursuit through their resemblance to their surroundings. Mr. Phillips captured most of the specimens by beating the branches over a butterfly net.

The name of the tree on which they were found is not known but my captive specimens feed readily on the leaves of *Eugenia jambolana* (Sinh. *maha dun*) which does not grow at that elevation. Larvae however, have not thrived in captivity so it is probable that the species is not truly polyphagous.

Mr. Phillips, who is so well-known for his work on Ceylon Mammals is foremost among the very few Planters whose interest in wild life reaches the practical stage of sending specimens regularly to the Museum, and I am indebted to him for many valuable insects. I take the opportunity to congratulate him on the discovery of this interesting Acridian.

Remarks. This species, as already indicated, appears to be more closely related to *T. gracilis* Uvarov than to the other Ceylonese species, and it will in all probability eventually be joined with the latter in a separate genus or sub-genus. Working as I am under the severe handicap of a complete lack of foreign material and with very inadequate literature, I am unable to offer any remarks on the relationship of the Ceylonese Tarbalei with those of Gilolo, Amboina and New Guinea, though I suspect that their resemblances are due to convergence rather than true relationship.

Eliya gibbosa, sp. nov.

Plate XXXII, figs. 1, 2, and 3

Female; (male unknown). Differs from the described species and from the following one in the strongly humped appearance of the middle of the body.

Antennae reaching further than the base of the hind femur, slender, nearly cylindrical, of even width throughout the flagellum. Face, genae and frontal ridge coarsely punctate; occiput, especially in a band running parallel with the hinder border of the eye, more finely punctured, with a slight median carinula from pronotal margin to the transverse sulcus which separates it from the fastigium of vertex. The latter is transverse, very broadly oval with its margins rounded, punctured and with a slight median carinula. Eyes broadly oval with their front margin less curved than the hind, separated dorsally by a space only slightly wider than the second antennal segment.

Pronotum evenly rounded, rather strongly compressed; its fore margin is slightly, and its hind margin strongly, roundedly produced, both being slightly emarginate medially. The transverse sulci are shallow but broad, especially in the middle of the dorsum, and have a tendency to be discontinuous medially. The anterior one is confined to the sides of the pronotum, the next crosses the dorsum but tends to become obsolete; the third is situated at about the second fifth, and the fourth, which is very broad, at about the third fifth from the fore margin. The lateral lobes of the pronotum are deep and broad, their anterior angles roundedly obtuse, the lower border oblique and slightly bisinuated, the

posterior margin strongly lobately produced without the slight thickening of the edge that is present on the lower and dorsal margins. Consequent on this produced, rounded lobe, there is well-marked humeral bay. (N.B. In the paratype specimen (see Plate XXXII, fig. 2) this lobe is not so pronounced as it is in the type, where is reaches almost to the thickened rim of the acetabulum of the hind femur.)

The surface of the pronotum is coarsely punctured in the prozona and less coarsely, but more closely, punctured on the metazona.

The prosternal tubercle is a simple, rounded hump, somewhat compressed, and about as high as long. The meso- and meta-sterna are as in the generic diagnosis (Uvarov, 1927, p. 103). The pleurae are sparsely punctured. The metanotum is almost completely covered by the posterior lobe of the pronotum. The first abdominal tergite (easily mistaken for the metanotum) is roundedly humped, (more so in the type than in the paratype) giving the insect a very characteristic appearance. The tegmina are very broadly oval, with the costal border somewhat lobately produced; their apices truncate and emarginate. In the type they overlap each other and conceal all but a small triangle of the first abdominal tergite and their apices extend slightly beyond the margin of the second; in the paratype they are altogether smaller, failing to meet each other by a millimetre or more and not reaching the margin of the second tergite. The importance of this disproportion must not be given too much weight in view of the fact that the tegmina have lost their original function and become vestigial organs in which a high range of variation is to be expected.

The limbs agree in structure very closely with those of the genotype, *E.pedestris* Uvarov (1925, p. 103).

The abdomen is almost smooth, having merely a few very shallow impressions along the dorsum.

Coloration. In life, some shade of green; in preserved specimens yellow-ochre with traces of a broad, brown, dorsal fascia. Face, genae and fastigium of vertex irregularly marked with small black spots, a few olivaceous marks on dorsum and sides of occiput. The dorsum of the pronotum shows the following black marks: a pair of small spots near the front margin, close to the middle line; a similar pair of spots much wider apart on the obsolete dorsal portion of the first transverse sulcus, and another pair close together shortly in front of the second sulcus; a pair of larger spots, wide apart, between the second and third sulci and another pair, close together, shortly in front of the fourth sulcus. The dorsal portions of the second, third and fourth sulci are broadly black. The dorsum of the first abdominal tergite is black (type), or dark olivaceous with an indefinite pale median line (paratype). The tegmina are pale greenish yellow with all the inter-venular spaces

filled in with black. Their anal margin is broadly black and the postero-internal area is suffused with dark brown. (N.B.—These tegminal marks are much paler and less pronounced in the paratype than in the type, which is altogether darker.)

The abdomen has many small black spots the arrangement of which may be seen in the figures (Plate XXXII, figs. 1 and 2).

The fore and mid femora and tibiae are irregularly marked with black spots of various sizes. The hind femora bear about 10 black spots along the outer dorsal carina, 5 or 6 on the outer ventral and 5 or 6 on the inner ventral carinae; in addition, there are a few very minute ones on the distal half of the middle dorsal carina, and a short double row on the dorsum of the knees; the sides of the latter are olivaceous dorsally, dirty pink ventrally, with a black mark on their proximo-ventral portion. The hind tibiae are blue-black variegated with pinkish, proximally, then with a pale, indefinite, yellowish annulation, their distal three-fourths being dark greenish blue; the hind tarsi are dull crimson. The meso- and meta-sterna are yellow with an ill-defined, macular, bluish medial band.

Vestiture. The insect is smooth and shining with a few scattered short setae almost everywhere, but more numerous on the fore- and mid-legs, sternum, genitalia. The black spots above mentioned each surround a fine seta; the lower median carina on the hind femora has a close row of small setae and the hind tibiae bear four rows of long, soft setae, their tarsi being similarly clothed. The posterior abdominal sternites bear short, ventro-lateral tufts of close-set setae such as are found in many other genera.

The tegmina of the type bear numerous long soft setae which are quite absent in the paratype; as they are very easily removed their absence in the latter may be due to damage.

Measurements

	Type ♀ mm.		Paratype ♀ mm.
Length	23.3	...	23.6
Width of head (including eyes)	5.1	...	5.2
Length of pronotum	7.0	...	6.8
Height of pronotum (measured as between parallels)...	5.5	...	5.4
Length of lateral lobe of pronotum	5.7	...	5.1
Length of tegmen (from humeral bay)... ...	5.0	...	4.5
Breadth of tegmen	4.25	...	3.8
Length of hind femur...	13.5	...	13.25
Breadth of hind femur	3.2	...	3.4
Length of hind tibia	12.0	...	12.0
Length of hind tarsus...	8.75	...	8.6

Material examined. Type female captured in jungle at Rakwana, in the Province of Sabaragamuwa on 4-v-29; paratype female taken in jungle at Wellawaya, Uva, on 5-i-28. The type will be presented to the British Museum (Natural History).

Remarks. The form of the pronotum is very different from that of other species of the genus and might be thought to warrant the erection of a new genus. It seems probable however, on the evidence of the meagre material of this genus available that its members are in a very plastic state and more material is necessary before forming any conclusion on the matter.

The differences noticed between the type and paratype may indicate varietal or sub-specific distinction, due probably to the difference in habitat; Rakwana being distinctly in the wet zone whereas Wellawaya is on the borders of the dry zone, with, of course, less luxuriant forest than the former; but this question too must await the collection of more specimens.

Eliya venusta, sp. nov.

Plate XXXII, figs. 4 and 5

Male. Head wider than the rest of the body, short, rather strongly reclinate. Antennae slender, cylindrical, reaching to about the middle of the posterior femora. Eyes dorsally separated by a narrow carina half the width of the third antennal joint. Fastigium of vertex slightly broader than long, sloping towards the front, with a small median carinula, irregularly rugulose discally; it is separated from the vertex by a deep and broad transverse sulcus. In front it curves sharply into the frontal ridge, which is broadest between the antennae, punctured and brokenly sulcate in its lower part. The face and genae are coarsely rugoso-punctate. The vertex is feebly medially carinulate, the carinula scarcely reaching the pronotal margin. On each side there is a band of irregular puncturation parallel to, but not contiguous with, the orbital margin.

The pronotum is semicylindrical, produced in front and behind, the fore margin minutely emarginate medially, the hinder very slightly bisinuate laterally. The transverse sutures are deep and broad, the first obsolescent medially. Prozona with large round punctures, metazona with close, fine ones. The prosternal tubercle is a round hump, somewhat compressed, with a tendency to be pointed in front. The mesosternal lobes are very rounded, separated by about two-thirds of their width; metasternal lobes contiguous. Mesopleurae sparsely punctured, metapleurae practically smooth.

Tegmina broadly oval, reaching to about the middle of the third abdominal tergite. Abdomen slender, compressed, slightly medially carinate, its surface smooth, with minute, obsolescent punctures. The supra-anal plate is elongate, transversely concave in the middle, terminating in a short cylindrical process which is truncate apically. The cerci are cylindrical, elongate, conical, extending a little beyond the supra-anal plate. The sub-genital lamina is strongly compressed, recurved upwards, with its apex, as seen in profile, broadened and pointed dorsally.

Limbs as in other members of the genus. Hind tibiae with 8 to 10 outer spines (including a small apical one) and 10 inner. Hind tarsi with the second joint longest.

Coloration. In life, green with the eyes brick-red. Antennae nearly black except at bases and tips which are greenish. There are minute black spots on the face. The pronotum has a variable number of pairs of small black spots, separated by varying distances, between the transverse sutures in the dorsal portion of the prozona (in the type, only the first pair, near the front margin, is conspicuous); there are three fairly large black spots on the hinder margin of the lateral lobes, a pair of large, and an inner pair of small, spots on the margin of the posterior lobe. The lower margin of the meso- and meta-pleurae is broadly black, their discal areas sky-blue. Tegmina deep indigo blue (nearly black) with a broad semi-translucent margin all round. They are traversed medially by a broad longitudinal fascia of sky-blue. The abdomen is yellowish green in its basal half, this colour gradually merging into sky-blue distally; dorsally it is traversed by a black fascia which is divided by a very narrow pale medial line. The lower lateral portion of each tergite bears a large blue-black blotch and the posterior margins of the hinder tergites are of the same colour.

The fore and mid femora and tibiae have large, rather definite black blotches on their outer surfaces. The hind femora bear 4 to 5 large, more or less round, black blotches along their outer dorsal carina, 3 to 4 similar ones along the outer ventral, 3 or 4 smaller ones on the inner dorsal, and 3 on the inner ventral in the distal half only. The hind femoral knees are blue-black with a yellowish blotch on the outer genicular lobes. The hind tibiae are blue-black proximally, then annulated broadly with green, then dull Prussian blue for their distal two-thirds. The hind tarsi are blackish merging into green on the third joint.

In dried specimens the ground colour has changed to a brownish yellow and there is little trace of the sky-blue patches on pleurae and abdomen.

Female. Antennae reaching to about the margin of the second abdominal tergite. Eyes separated dorsally by a carina about as wide as the third antennal joint. Occiput sparsely and shallowly punctured; with a median carina which reaches the pronotal margin. The fastigium of vertex is transverse, broadly oval, coarsely punctured, with a median carinula. The facial ridge is distinct only above the ocellus, coarsely punctured from shortly above the ocellus downwards, the punctures tending to unite to form an irregular sulcus. The rest of the face is coarsely rugoso-punctate. The pronotum has its fore and hind borders shaped as in the male and the sutures are similarly deep and wide. The prosternal tubercle is similar to that of the male. It is much shorter longitudinally than that of the genotype. The mesopleurae are sparsely punctured, metapleurae smooth. The limbs are as in the genotype but the hind femora are considerably less compressed.

The tegmina extend more or less to the middle of the third abdominal tergite and are broadly oval with their tips somewhat produced and roundedly pointed; the outer apical margin is rather deeply, obliquely emarginate.

The abdomen is smooth and shining. The supra-anal plate is narrow, tapering, rounded at apex, with a deep transverse fold across it opposite the bases of the cerci.

Coloration. This differs in some details from that of the male; she resembles him, however, in that the ground colour is rich green, also in the coloration of the antennae and the marking of the fore- and mid-legs. There is a faint, broad, brownish, longitudinal fascia on the pronotum and the pronotal spots of the male are represented by four obsolescent ones on the postero-dorsal margin.

There is a broad, white fascia extending from the lower margin of the eye across the lower part of the lateral lobes of the pronotum and across the pleurae; below, this fascia is bordered by a dark fascia of olive green to black, and there is a similar, incomplete black fascia above it. The tegmina lack the conspicuous sky-blue fascia of the male but have their venation dirty greenish in the costal area, reddish brown elsewhere, with some of the principal veins pale, giving the tegmina a longitudinally striped appearance. All the intervenular spaces are filled in with black, and there is, as in the male, a semi-hyaline margin all round.

The metanotum and first abdominal tergite are more or less black. There is no black medial fascia on the abdomen but the lateral markings are as in the male. There is an indefinite, macular, greenish-blue, ventral fascia from the centre of the mesosternum to the end of the abdomen.

The hind femoral black spots are much fewer and smaller than in the male, there being none on the two outer carinae and but 3 or 4 small but distinct ones on the distal half of the inner dorsal and ventral. The knees and tibiae are coloured as in the male but the hind tarsi are crimson-pink on their outer side, black elsewhere.

Vestiture. In both sexes there is a sparse covering of fine setae almost everywhere, but most numerous on the limbs, sternum, genitalia, ventral carina of hind femur, and especially on the hind tibiae and tarsi where they are long and soft; the setae are pale coloured except on the inner side of hind tibiae and tarsi where they are dark brown. In my drawings I have made no attempt to indicate these setae as it is impossible with a medium such as pen and ink to avoid exaggerating their size and relative visibility and therefore it seems to me preferable to omit them altogether.

Measurements

		♂ mm.		♀ mm.
Length ...	...	17.75 to 19.0*	...	22.7 to 24.0
Length of antenna ...	...	13.0 to 13.5	...	13.0 to 13.8
Width of head ...	...	4.0 to 4.1	...	5.0 to 5.2
Length of pronotum ...	...	4.0	..	5.8 to 6.0
Length of tegmen ...	...	3.7 to 3.8	...	6.0 to 6.5
Length of hind femur	...	10.5 to 10.6	...	13.3 to 14.0
Breadth of hind femur	...	2.7	...	3.3 to 3.35
Length of hind tibia	...	9.5	...	12.0
Length of hind tarsus, about	...	7.7	...	9.2 to 9.4

Material examined. Type male and a female captured at Rakwana, 4-v-29; 1 female, 10-ix-26; a male, 14-i-32; and a female, 17-viii-32; all taken at Labugama. The specimens were found in jungle undergrowth consisting mainly of the small bamboo, *Ochlandra stridula.* The type male and a paratype female will be presented to the British Museum (Natural History).

Remarks. This species rather closely resembles *E.pictipes* Uvarov (1927, p. 104) with the type of which I have compared it at the British Museum. *E.pictipes* however lacks the whitish, black-bordered lateral fascia, the puncturation on the head and pronotum is less pronounced, the pronotal transverse fissures are less deep, the lateral lobes are less produced at postero-lateral margin, the hind femora are less spotted and their knee lobes are smaller, and the tegmina are bright green on their costal area.

As the males have not been taken *in cop.* with the females there is, of course, no proof that they are conspecific; but of this there can, I think, be little doubt as the males agree in all essentials with the females and the localities are the same.

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* N.B.—The abdomen in this specimen (the type) is somewhat extended.

Eliya pedestris Uvarov

This species, the genotype, was described (Uvarov, 1927, p. 103) from a series of females. As two males have since been obtained, which I consider to be conspecific with the females, I offer the following description. One of them was captured at Kikilimana, Nuwara Eliya, on 28-iv-27; and the other was sent in by Mr. W. W. A. Phillips from Mousakande Estate, Gammaduwa, on 28-ix-32. The Gammaduwa specimen is considerably larger than the Nuwara Eliya one but I can detect no important structural difference between them and so conclude that they are of the same species.

General shape similar to the male of *E.venusta* but rather more stoutly built. Head broader than pronotum. Antennae stouter than those of *E.venusta*, reaching about to the middle of the second abdominal tergite. Fastigium of vertex much as in the female but with the median carina rather more distinct. Vertex between eyes forming a carina about as wide as the third antennal joint. Frontal ridge and sculpturing of face, genae, and occiput as in the female.

Pronotum similar in general shape and sculpture to that of the female, but proportionately narrower. Prosternal tubercle rounded, slightly compressed, inclined to be pointed in front. Mesosternal lobes broadly rounded behind, their interspace about two-thirds of their width; metasternal lobes practically contiguous.

The tegmina are broadly-oval scales, closely adpressed to the body, which do not nearly reach the posterior margin of the metanotum (in the Nuwara Eliya specimen a minute semi-circle of the right one only is visible, protruding from beneath the pronotal margin).

The external genitalia are similar in general shape to those of *E.venusta*, but the supra-anal plate is relatively broader and the cerci are not longer than it.

Coloration. In life, the Gammaduwa specimen showed the following coloration. Antennae black. Head, pronotum and an indefinite band on the dorsum of the rest of the body pale grey mottled with faint purplish and greenish; tegmina bright crimson-pink; pleurae, sides and venter of abdomen yellowish green; fore and mid femora and tibiae bright green irregularly spotted with black, their tarsi dark grey mottled with greenish. Hind femora bright green with a series of black chevron-shaped marks on each side following the outlines of the angulated transverse fissures. The upper part of the external face of the knees is black, the lower part pinkish white; the internal face is black. The hind tibiae are black proximally, with a whitish spot on the apex of the ' knee ', then yellowish green which gradually changes to the bright blue of the distal two-thirds or so. The tibial spines are black almost throughout. The hind tarsi are pink on their external border, blue elsewhere. These colours have of course changed greatly in the preserved specimen.

The Nuwara Eliya specimen is very much discoloured but the limbs can be seen to be coloured and marked with black as in the other.

Measurements	Nuwara Eliya ♂ mm.	Gammaduwa ♂ mm.
Length	15.0	18.75
Length of antenna, about	8.0	10.0
Width of head	3.75	4.5
Length of pronotum	3.2	4.0
Length of tegmen	0.3	1.0
Length of hind femur	10.0	12.0
Breadth of hind femur	2.1	2.45
Length of hind tibia	9.0	11.0
Length of hind tarsus, about	7.0	8.2

In addition to these two males, the Colombo Museum possesses a female paratype from Urugalla, 11-iv-23, and another female from the same locality, 14-iv-30.

Cercina phillipsi, sp. nov.

Plate XXXIII, figs. 1 and 2

Male. Antennae short, slightly flattened, distally distinctly broadened; they reach about to the metazonal suture on the pronotum or a little beyond it. Eyes somewhat prominent, oval, with the front margin less curved than the hinder. Face somewhat reclinate. Frontal ridge broadly, shallowly sulcate and finely punctured; with its sides slightly convergent above the antennae, below them parallel, not well-marked below the median ocellus and obsolescent before the clypeus is reached; the lateral facial carinae well-marked; a straight sulcus from the lower margin of the eye to the anterior mandibular articulation. The face is rugoso-punctate, also the lower part of genae. The fastigium of vertex is short, transverse, rounded in front, shallowly concave. The sides of the vertex between the eyes are slightly raised and parallel. The dorsum of the head is smooth but not shining.

The pronotum is semi-cylindrical, broadly rounded in front and behind, with a very slight median emargination in front and a slightly deeper one behind. The median carina is distinctly indicated, cut by the three posterior sulci. The pronotum is rather coarsely punctured —more finely on the metazona—, with smooth callosities on the upper part of the lateral lobes. The latter have their anterior angle very obtuse and rounded, the posterior part of the lower margin obliquely ascending, posterior angle obtuse, humeral bay distinct.

The prosternal tubercle is strongly antero-posteriorly compressed, broad at the base and convexly tapering to an acute apex. The

mesosternal lobes are rounded behind, separated by a space about ¼ of their width; the metasternal lobes are contiguous. The pleurae are irregularly punctured.

The tegmina are oval, very roundedly angulated at the tip, with the costal margin somewhat expanded in the distal half, reaching to the middle, or a little less, of the second abdominal tergite. The metanotum and the abdominal tergites are shallowly punctured, the punctures becoming obsolescent posteriorly.

The fore and mid femora and tibiae are fairly stout, nearly cylindrical. The hind femora have their dorsal carina terminating distally in a small, but distinct, acute tooth and the genicular lobes on each side are spinose. The posterior tibiae bear 8 outer and 10 inner spines (including small apical ones in each case).

The supra-anal plate is broadly triangular, emarginate on each side, with the apex somewhat acute-angled. The cerci are broadly laminate, slightly curved upwards, with their dorsal and ventral margins almost parallel, the distal margin angularly excised to form two lobes of which the dorsal is much smaller than the ventral. The subgenital lamina is short, seen from below forming almost an equilateral triangle with convex sides.

Coloration. The following description was drawn up from fresh specimens and due allowance must be made for discoloration in pinned examples.

Antennae, except basal two joints, crimson, darker distally. Eyes pale sordid yellow, infumated dorsally. Margin of fastigium of vertex dark olive, dorsum of head and pronotum and inner halves of tegmina dark green. Basal two antennal joints, face, cheeks, mandibles sordid pale yellow; sides of pro-, meso-, and meta-thoraces pale yellow which becomes progressively suffused with pink posteriorly. A dark olive stripe extends on each side from the dorsal half of posterior margin of the eye, across the pronotum, outer half of tegmina and along the sides of the abdomen, gradually disappearing on the posterior tergites. The pleural sutures on meso- and meta-thoraces are outlined with black. An indefinite band of sullied, cupreous orange extends along the dorsum of the abdomen, not reaching the end. Sides of abdominal tergites, below the dark stripe above mentioned, bright yellow, suffused with pink on the distal halves of the posterior tergites. Sternum and basal abdominal sternites bright yellow, the latter increasingly suffused with vermilion until the posterior ones are altogether of this colour. Genitalia dull crimson. Fore and mid legs bright green, hind femora bright green with black knees. Hind tibiae greenish blue with spines pale at base, black in their distal halves. Hind tarsi crimson.

Female. The female resembles the male in most details of structure, sculpture etc. but differs in the following points: more stoutly built, eyes less prominent, fastigium of vertex shorter and broader, space between eyes much broader. The mesosternal lobes are separated by a space equal to about half their breadth and the metasternal lobes are narrowly separated.

The supra-anal plate is narrower than in the male, divided in the middle by a transverse furrow. The cerci are short, conical and compressed. The valves of the ovipositor are finely serrated, the lower pair much more slender than the upper. The subgenital lamina bears a strong median spine distally.

In the main features of coloration the female resembles the male but is less handsomely marked and tends to be of a brighter green. It shows two varieties which differ in the colour of the dorsum. In one, the whole dorsum of head, thorax tegmina, and abdomen is of a pale pinkish brown bordered laterally by a dark crimson-brown fascia extending from the eye to the end of the thorax and then gradually diffusing away on the abdomen. Above, on head and pronotum this fascia is narrowly bordered by a pale line, and, below, it is separated from the yellow-green of the face and lateral lobe of the pronotum by a bright yellow band.

The other variety has the dorsum and tegmina dull green. In both, the legs are coloured as in the male, but the hind femoral knees are much less dark.

Measurements

	♂	♀ mm.
Length of body	16.5 to 20.0 ...	18.0 to 22.0
Length of antenna	4.5 to 6.0 ...	4.2 to 6.8
Width of head including eyes ...	3.1 to 3.6 ...	3.8 to 4.3
Length of pronotum	3.5 to 4.5 ...	4.5 to 5.2
Width of pronotum	3.0 to 3.7 ...	4.0 to 5.0
Length of tegmen	3.1 to 4.0 ...	3.9 to 4.7
Width of tegmen	1.4 to 1.75 ...	1.8 to 2.5
Length of hind femur	9.1 to 11.0 ...	11.0 to 13.5

Material examined. The first specimens of this species collected were five males and two females captured by me on a small patch of grassy "patana" surrounded by jungle at Mousakande Estate, Gammaduwa, *circa* 4000 feet, on 5 and 6-xi-29 while I was the guest of Mr. W. W. A. Phillips, in whose honour I have named the species. Since then a further 10 males and 25 females have been collected from the same locality, partly by myself and partly by Mr. Phillips, in February, March, April, August, September and October of this year (1932). From this material I select as type a male taken on 1-viii-32. With a series of paratypes of both sexes, it will be presented to the British Museum (Natural History).

Remarks. This species is closely related to the genotype, *C.obtusa* Stål. It is however slightly larger and differs in the shape of the head, in having coarser puncturation and stronger median carina on pronotum, more strongly developed acute tubercle at distal end of dorsal carina on hind femora, in the shape of the male cerci, less strongly developed armature of the valves of the ovipositor, and especially in coloration. The two species are easily discriminated by the colour of the hind tibiae, which are bright orange red in *C.obtusa* and greenish-blue in the new species.

Ochlandriphaga[1] gen. nov.

Of medium size, brightly coloured. Body larviform, in profile conical, tapering from the large head. Antennae very long, slender and nearly cylindrical. Head large, very slightly reclinate, with the dorsum globosely elevated. Fastigium of vertex short, transverse, smooth, with rounded margins, curving evenly into the facial scutellum, separated from vertex by a transverse furrow. Facial ridge, somewhat narrow, shallowly sulcate above and below the median ocellus, nearly parallel-sided, straight in profile. Eyes large, oval and prominent.

Pronotum deep, semi-cylindrical, slightly compressed, broadly rounded in front and behind, with no trace of median or lateral carinae; with four well-marked transverse sulci of which the anterior is obsolete in the middle. Prosternal tubercle transverse, antero-posteriorly compressed, truncate and pedunculate (see Plate XXXIV, figs. 3 and 4).

Meso- and meta-sternal lobes rounded, the latter separated in the female, almost contiguous in the male. Mesonotum concealed by the pronotum. Metanotum and first abdominal tergite with their surface somewhat irregularly transversely crumpled or wrinkled. Tegmina in both sexes abbreviated, lateral, irregularly oval in shape.

Tympana in first abdominal segment well developed, concealed by the tegmina. Abdomen much shorter than hind femora, somewhat compressed, slightly carinate, tapering. The distal 3 or 4 sternites bearing ventro-lateral tufts of pilosity. Male supra-anal plate broadly triangular with emarginate sides. Male cerci conical, acute, strongly compressed. Female supra-anal plate narrower than that of the male, transversely furrowed across the middle. Cerci short, conical, nearly cylindrical. Valves of ovipositor denticulate, the ventral pair more slender than the dorsal.

Fore and mid legs fairly stout, normal. Hind femora with dorsal carina terminating in a minute tooth; its genicular lobes spinose. Hind tibiae with a small outer apical spine. Hind tarsi fairly long, the metatarsus somewhat flattened and expanded laterally, third joint longest.

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[1] *I.e.* feeding upon *Ochlandra stridula*, the small jungle bamboo.

Genotype: *Ochlandriphaga xanthelytrana, sp. nov.*, described below. Dr. Uvarov, to whom specimens were submitted, in confirming my impression that this insect constitutes a new genus, states *in epistola* that it is allied to *Chitaura* I.Bolivar, but differs in the following particulars: antennae long and slender; pronotum rounded behind, not excised; hind tibiae with a minute apical spine on the outer side; prosternal tubercle truncate at apex, not tridentate as in *Chitaura*.

Ochlandriphaga xanthelytrana, sp. nov.

Plate XXXIV, figs. 1 to 5

Male. Antennae nearly as long as the body minus head, of nearly even width throughout, 22- to 24- segmented. Face and lower part of genae coarsely rugulose; vertex irregularly punctured, smoother along the median line. Fastigium smooth, very feebly pitted, with a trace of a median sulcus. Pronotum coarsely rugulose, its third transverse sulcus slightly before the middle, fourth at about the second third from the front margin. Lateral lobes deep, broadly rounded in front, roundedly angulate behind, shallowly emarginate on posterior margin. Tegmina oval but more convexly curved on the costal margin than on the inner, not extending much beyond the first abdominal tergite; their venation indicated by small punctures representing the intervenular spaces. Metanotum uneven-surfaced and with minute transverse wrinkles. The first abdominal tergite similarly sculptured and slightly longitudinally humped. Second two abdominal tergites minutely, transversely-wrinkled for a short distance on each side of the median carina.

Supra-anal plate longitudinally concave on each side and, in its basal half, in the middle; its apex forming a little more than a right angle.

Hind femora surpassing the abdomen by about a third of their length.

Coloration. Antennae yellow at base and terminal three joints, otherwise greenish black. Fastigium, region at base of antennae and inner margin of orbits bright yellow. Rest of head, pronotum, and mesepimeron in life pale greenish blue, mottled in the punctures with brownish; in dried specimens various shades of yellowish brown. In living individuals there is a narrow marginal band of dark grey on the front and hind margins of the pronotum; this has practically disappeared in the preserved specimens.

The tegmina are bright yellow with a narrow black margin and small black inter-venular punctures. The meso- and meta-nota, first, second, and most of the third abdominal tergites; a dorsal band on the others; and the genitalia, are shining black; remainder of tergites and the sternites bright yellow (discoloured in preserved specimens).

Fore- and mid-femora yellowish green their tibiae light green, tarsi ochreous; hind femora green with black knees, their tarsi ochreous.

Vestiture. The whole insect is very sparsely clothed with long, soft, pale setae which are most numerous on the tibiae and tarsi, and are very sparse on the meso- and meta-nota and abdominal tergites. As mentioned in the generic diagnosis, the posterior sternites bear ventro-lateral tufts of fairly dense pubescence.

Female. The female resembles the male but is larger and more stoutly built with a disproportionately large head. Her antennae would about reach to the end of the metanotum.

Measurements

		♂ mm.		♀ mm.
Length of body, about	...	18.0 to 19.0	...	24.5
Length of antenna	...	15.0 to 16.0	...	13.0
Length of pronotum	...	4.0	...	5.0
Length of tegmen	...	3.0 to 3.75	...	4.5 to 5.0
Length of hind femur	...	13.0	...	15.5 to 16.0
Width of head including eyes	...	4.0 to 4.2	...	5.1 to 5.2
Width of interocular space	...	1.0	...	1.5
Width of pronotum	...	3.5 to 3.75	...	5.2
Width of tegmen	...	1.6 to 1.75	...	2.2 to 2.5

Material examined. 12 males and 5 females all captured at Labugama, Western Province, on the following dates: 9-iii-31; 15-ix-31; 14-i-32; 17-vi-32; 2-viii-32; and 15 to 18-viii-32. From among this material I select as type a perfect male taken on 17-vi-32. It will be presented to the British Museum (Natural History), with some male and female paratypes.

The specimens were all captured in jungle undergrowth consisting of the small wet-zone bamboo, *Ochlandra stridula* Thwaites, on the leaves of which they were feeding. Several of the specimens were taken as young larvae and reared to maturity in my laboratory where they were fed on the ornamental yellow bamboo, to which they fortunately took kindly in the absence of *Ochlandra.* The larvae appear to be gregarious, as on several occasions four or five of them were found feeding in close company.

The species is rather hard to catch as its leaps are very swift and vigorous.

Bambusacris, gen. nov.

Belonging to the Catantopinae but with a Pyrgomorphine facies somewhat suggestive of *Orthacris*. Dr. Uvarov informs me that it is not very far from *Pseudocarsula* Kirby.

Form long and slender, slightly compressed. Antennae inserted quite in front of the eyes; those of the male long, slender, cylindrical, and with flagellum of even width throughout; those of the female

shorter, broad and triangular in section at base of flagellum, tapering and becoming cylindrical towards the tip. Head long, strongly reclinate; eyes oval, not very prominent; median ocellus quite obsolete. Fastigium long, pointed, horizontal, longitudinally sulcate, and with dorso-lateral shallow foveolae; Frontal ridge, in profile, only slightly sinuated below antennae; sulcated except at its anterior (dorsal) extremity, where in the form of an acute carina, it meets the fastigium at a sharp angle which tends to be de-curved in the male; its sides gently diverging ventrally. Lateral facial carinae well-marked, divergent ventrally. The galeae are long, pointed lobes doubled over the apex of the mandibles and overlapping the labrum.

Pronotum shorter than the head, rounded above, of nearly even width throughout; somewhat compressed, truncate or slightly emarginate in front, angularly emarginate behind; median and lateral carinae absent; transverse sulci shallow but well-marked. Lateral lobes rather deep, obtuse-angled in front, posterior angle roundedly produced.

Prosternal tubercle transversely expanded distally, somewhat pedunculate, truncate at apex. Meso- and meta-sternal lobes contiguous in both sexes, and of the shape shown in Plate XXXV, fig. 6.

Tegmina very abbreviate, narrow; wings apparently absent.

Fore- and mid-legs short, rather slender, their femora only slightly compressed. Hind femora not reaching the end of abdomen, slender, their carinae smooth and not very pronounced; the dorsal carina terminating in a very minute, obtuse tubercle; genicular lobes short, pointed but not spinous. Hind tibiae straight, with a small apical outer spine. Hind tarsi fairly long, the third joint longest.

Abdomen long and slender, slightly medially carinate. Auditory tympanum well developed. Cerci in both sexes nearly cylindrical, conical, acute.

Genotype: *Bambusacris greeni*, sp. nov. described below.

Bambusacris greeni, sp. nov.

Plate XXXV, figs. 1 to 6

Male. Antennae reaching well beyond the base of hind femora. Head smooth but opaque. Pronotum feebly punctured, as are also the meso- and meta-pleurae. Tegmina narrow and parallel-sided, rounded at apex, in some individuals reaching to the middle of second abdominal tergite, in others only to its base. Abdomen almost smooth, feebly medially carinate. Supra-anal plate forming roughly an equilateral triangle with convex bisinuated sides and bluntly pointed apex; shallowly sulcate medially. Sub-genital lamina forming a cylindrical blunt cone which points straight backwards.

Hind tibiae with 10 to 11 outer spines (including a minute apical one) and 12 inner. Hind tarsi with third joint, including empodium, nearly equal to the other two together.

Coloration. Antennae dark brown, greenish on proximal two segments. Dorsum of head, thorax and abdomen, with tegmina, fore- and mid-legs and hind femora dull green. Ventral half of head and body greenish ochraceous, and there is a trace of a median dorsal stripe of the same colour on occiput. Hind femora with an indefinite, brown and black spot on upper part of sides of knees; hind tibiae basally greenish black, remainder dull greenish blue, spines dark brown; hind tarsi dull pale greenish blue.

Vestiture. The insect is very sparsely pilose almost throughout, somewhat more thickly so on the meso- and meta-sterna and on the limbs. The abdominal sternites, especially the posterior ones, bear ventro-lateral tufts of long setae; the sub-genital lamina, cerci and posterior tibiae and tarsi are longly pilose.

Female. The female is considerably larger and stouter than the male. Antennae not quite as long as head and pronotum. Her sculpture and vestiture are similar to his; her tegmina are of the same shape and proportions. Her supra-anal plate forms a triangle about 1½ times longer than broad, roundedly pointed at tip. The lower valves of ovipositor are much shorter and slighter than the upper; edges of both smooth, not dentate.

In coloration the female shows two varieties. The first is similar to the male but duller, and somewhat brown along the dorsum; in the other, green is replaced by light brown, and the lateral ochreous stripe on head and thorax is paler and more distinctly marked, a dark stripe extending along its dorsal border from behind the eye to the hind coxa. In this form, the inner surface of the hind femora is brownish orange and the hind tibiae are dark yellowish grey. One of the specimens at hand seems to be intermediate between the two forms.

Measurements

		♂ mm.		♀ mm.
Length of body	...	23.5 to 25.5	...	29.0 to 32.0
Length of antenna, about	...	13.0 to 15.0	...	10.0 to 10.5
Length of eye	...	2.2	...	2.6 to 2.75
Width of head including eyes	...	2.25 to 2.5	...	3.0 to 3 2
Length of pronotum	...	3.0 to 3.2	...	4.0 to 4.5
Greatest width of pronotum	...	2.0 to 2.2	...	2.75 to 3.0
Length of tegmen	...	3.3 to 4.0	...	4.5 to 4.8
Width of tegmen	...	0.7 to 0.75	...	1.0
Length of hind femur	...	10.5 to 11.0	...	12.5 to 13.0
Length of hind tarsus	...	4.5 to 4.8	...	5.0 to 5.7

Material examined. **15 males and 16 females, all captured at Labugama, Western Province, 200 to 400 feet, on the following dates; 10-ix-26; 9-iii-31; 30-v-31; 15-ix-31; 17-vi-32; 2-viii-32; 15 to 18-viii-32.**

I select as type a perfect male captured on 2-viii-32; with a series of paratypes of both sexes it will be presented to the British Museum Natural History), the remaining paratypes being retained in the Colombo Museum.

In addition to the above-mentioned material, in 1930 I found an old damaged male specimen labelled merely 'Ceylon' in the British Museum, which had been presented to the National Collection by Mr. E. E. Green who is therefore the discoverer of this interesting insect. It gives me especial pleasure to name the species in his honour.

Habits, etc. This insect feeds on the jungle bamboo, *Ochlandra stridula* Thwaites, and is not uncommon. Several of the above-mentioned specimens were taken as young larvae and reared to maturity, feeding readily on the ornamental bamboo of Colombo gardens. It is inclined to be sluggish but if once alarmed it jumps powerfully and smartly.

Pairs kept in captivity mated repeatedly and oviposition in earth was observed but no young hatched. One gravid female was dissected and found to contain only four mature eggs, of a yellow colour which measured 5.3 × 1.2 mm.

The young larvae are coloured pale ochraceous and have a conspicuous white dorsal fascia throughout their length. Their short antennae are carried porrect and closely apposed.

Ischnacrida gracilis, sp. nov.

Plate XXXVI, figs. 1 to 4

Male; (*female* unknown). Smaller than *I.vittata* F. and differing also in the proportions of the fastigium, facial ridge etc.

Antennae about as long as the head and pronotum, or a lttle longer, ensiform, tapering evenly to the tip; the fourth to six joints broadest, considerably broader than the vertex between the eyes. Fastigium of vertex considerably longer than broad, shallowly sulcate, separated from vertex by a slight transverse sulcus. (In one (type) of the two adult specimens before me it is more acutely pointed in front and straighter on the sides than in the other, which is the specimen figured; see Plate XXXVI, fig. 2). The foveolae are impressed, punctured; there is a small median carina on the vertex and traces of lateral carinae at the inner orbital margins. Frontal ridge in profile nearly straight, slightly emarginate below the median ocellus; in front view, its sides diverge irregularly from above to the median ocellus, then are slightly bowed inwards, diverging again and becoming obsolete before the clypeus is reached. Its surface is coarsely punctured as are also

the sides of the face below the pearly lateral fascia. The occiput has on each side a zone of shallow, somewhat transverse punctures and it is obsolescently punctured on the sides as well.

The pronotum is semi-cylindrical, compressed, almost parallel-sided, with its front margin almost evenly rounded, its hind margin roundedly produced. There are no lateral carinae but a slight trace of a median one in the metazona. Except on the pearly margin of the lateral lobes, its surface is coarsely punctured with round pits which are smaller and closer-set on the metazona than elsewhere. The prosternal tubercle is compressed on the sides, slightly expanded into a round knob at the tip. The pleurae are coarsely punctured with round pits above and below the pearly lateral fascia.

The tegmina are long and narrow, reaching to the middle or distal margin of the sixth abdominal tergite; they are broadest a little beyond the middle, with the scapular area considerably expanded and with rather regular, sigmoid cross-veins. The space between the scapular and radial veins in the middle third of the tegmen is set almost at right angles to the general surface and the area between the median and discoidal in the same region is set with regular, parallel cross-veins which project strongly above the surface and in certain lights show up as a distinct band. In the folded condition these cross-veins are in position to be scraped by the inner ventral carina of the hind femora, and I have no doubt that the whole apparatus is an efficient stridulatory organ. A precisely similar arrangement of the veins occurs in *Leptacris filiformis* Walk. and doubtless in other species of these two genera.

The fore femora are nearly cylindrical in section and obscurely punctured; the mid femora are somewhat compressed and rugoso-punctate on their outer surface; the hind femora reach to about the middle, or less, of the fourth abdominal sternite and are slender, with sparse obsolescent punctures and the carinae not strongly developed. The posterior tibiae bear 17 to 21 outer and 24 to 28 inner, small, black-tipped spines.

The supra-anal plate is bicarinate in the middle, the two carinae projecting distally to form a small gutter-shaped process. The sub-genital lamina is as long as from the front or hind margin of the eyes to the hind margin of the pronotum, its height from one quarter to nearly one fifth of its length (measured laterally).

Coloration. In life pale green, faded to greenish brown in pinned specimens. There is a broad fascia of white with a beautiful nacreous lustre extending from the base of the antenna, below the eye, along the lower border of the pronotum, across the pleurae and hind femora

where it gradually breaks up and becomes obsolete. (N.B.—In the two adult specimens before me the femoral stripe is somewhat difficult to distinguish from the ground colour; it is very conspicuous however in a penultimate instar larva and I am satisfied that it is present in the adults too but is obscured through having become infiltrated with grease.)

The face below the fascia is somewhat dusky, and an indefinite dusky line borders it above from the lower border of the eye to the end of the pleurae. A narrow, indefinite pearly line extends from the postero-dorsal margin of the eye to the pronotal margin and several other pale lines run parallel with it on the dorsum and sides of the head. The antennae are pale reddish brown, the eyes pale castaneous crossed obliquely by six concentric dark brown lines, which are not evenly spaced.

The tegmina have their membrane hyaline with pale greenish veins in the mediastinal, scapular and discoidal areas, those in the remainder of the tegmen being pale brownish. A very scattered and irregular row of small brownish spots passes along the middle of the tegmen. The wings have their membrane very pale pinkish at the base, slightly dusky-hyaline distally, with the veins crimson pink basally, becoming dark brown distally. The pink shade suffuses the meso- and meta-nota and also the small axillary membrane of the tegmina.

Measurements

	Type ♂ mm.	Paratype ♂ mm.
Length of body	46.5 ...	47.5
Length of antenna*—about	10.0 ...	10.5
Breadth of antenna	0.9 ...	1.0
Length of pronotum	4.8 ...	4.9
Length of tegmen	23.5 ...	24.5
Greatest breadth of tegmen	3.0 ...	3.0
Length of hind femur	13.0 ...	13.5
Length of sub-genital lamina	6.3 ...	8.5

Material examined. Type and another male, and a male larva in the penultimate instar, captured in a grassy glade in the Bintenna district about 12 miles east of Alutnuwara on 11-x-28.

The type will be deposited in the British Museum on publication of this paper.

* Extreme tips broken off.

Pelecinotus lankae, sp. nov.

Plate XXXVI, figs. 5, 6, and 7

Male. Head rugose on vertex, clypeus and labrum, punctured on frontal ridge and face, and with few small, scattered, shiny tubercles on face and genae. Frontal ridge shallowly concave, with its carinae widest apart between the antennae, rather suddenly converging opposite the median ocellus, and then parallel to the clypeal margin. The antennae are slightly compressed especially towards the tip, their surface minutely and closely punctured; they would extend nearly to the posterior apex of the pronotum. Eyes oval, slightly narrowed dorsally, with their anterior margin less curved than the posterior.

Pronotum with the median carina very high, crested, and strongly compressed, its highest point opposite to the posterior sulcus; its margin crenulated in the anterior half, strongly serrate or denticulate in the posterior half, its contour as shown in Plate XXXVI, fig. 5. The sides of the crest are deeply and coarsely pitted, the pits on both sides corresponding to some extent so that they are separated only by a thin lamina of translucent chitin. The transverse sutures are well-marked and, at the base of the crest, very deep. The surface of the pronotum is deeply punctured near the anterior margin, on the lower part of the lateral lobes and almost throughout the metazona. Scattered irregularly almost everywhere, but most concentrated on the metazona there are shiny, round, vitreous-looking tubercles. The hinder border of the metazona, from apex to ventral margin, is broadly thickened and of a different colour from the remainder of the pronotum.

The prosternal tubercle is a long, cylindrical, tapering process, projecting vertically downwards. The meso- and meta-sterna are closely but shallowly punctured all over; their shape may be seen in Plate XXXVI, fig. 7.

The tegmina are broadly oval, with their costal margins deeply rounded and their inner (anal) margins two-thirds covered by the posterior lobe of the pronotum. The pleurae are coarsely punctured and rugose. The abdomen is short, compressed and strongly recurved (in preserved specimens). The sternites are somewhat medially carinate and both they and the tergites are closely but shallowly punctured. The supra-anal plate is broadly oval with its apex acutely produced; a pair of contiguous carinae extend from the base to about

the middle where they merge into one broad carina which becomes obsolete before reaching the apex. The cerci are short, cylindrical, conical.

The fore and mid legs are stout, their femora coarsely but shallowly punctate. The hind femora are stout, extend much beyond the abdominal apex, and have their dorsal inner and outer carinae—which are very far apart—strongly tuberculate. The lower external carina is similarly but more finely tuberculate. The surface of the femora, especially between the two dorsal carinae, is coarsely rugose and tuberculate. The hind tibiae bear 7 to 9 outer spines (no apical one), which evenly increase in length distally; there are 9 to 11 inner spines, including an apical one, of which the fourth, fifth, and sixth are the longest—longer than any of the outer spines and approximately equal in length to the width of the tibia; the spines proximal and distal to these decrease gradually in length. The first and third hind tarsal joints are approximately equal in length.

Coloration. The colours of the living insect are as follows: general colour bright green; antennae dark purplish brown; eyes pale yellow with a long, oval, black, central mark which gave the creature a ludicrously smug and solemn appearance; summit of the pronotal crest chrome yellow; thickened hinder margin of pronotum, from apex to ventral border, pure white; an oblique band on the mes-episternum and mes-epimeron, bordering the hind margin of the lateral lobes of the pronotum, deep ultramarine blue; tegmina olive green with the inner margin white; fore and mid femora green, the latter with a white mark at the base continuous with a similar white mark on the coxae; hind femora green with the outer dorsal carina chrome yellow and the dorsum of knees raw sienna; all tibiae and tarsi purple except the proximal portion of the hind tibiae which is green.

In the preserved specimens these brilliant colours have given place to a dingy brownish yellow almost throughout. The eyes retain their black centres however, and the hinder border to the pronotum is dirty yellowish white and the pleural mark is blackish.

Female. This sex was unknown until this paper was in the press, when I was fortunate enough to capture several specimens, as well as additional males, as detailed below. It is at least twice as large as the male and very heavily built, but otherwise agrees in most details of structure and coloration with the description given. The thickened hind margin to the pronotum is reduced to a narrow rim and is not white; the tibiae are paler coloured; the metasternal lobes are widely

separated; the valves of the ovipositor are stout, acute, strongly curved, not serrated; the ventral pair very deep proximally, rather slender apically. The abdomen in a gravid female was, in life, very long and straight, in younger individuals much shorter and somewhat recurved.

Measurements

	♂ mm.	♀ mm.
Length, approx.	19.0 to 20.0	41.0 to 49.0
Length of antenna, approx.	13.5 to 14.5	16.2 to 18.0
Length of eye	2.9	3.7 to 3.8
Height of head	7.5 to 8.0	13.5 to 14.7
Length of pronotum	13.0 to 13.5	25.2 to 27.0
Greatest height of pronotum	10.0 to 11.0	19.0 to 20.5
Length of tegmen	6.0 to 6.6	12.5 to 13.8
Length of hind femur	14.5 to 15.0	22.0 to 24.5
Greatest breadth of hind femur	4.0 to 4.3	6.0 to 7.0
Length of hind tibia	14.5 to 15.0	22.5 to 25.0

Material examined. Two males captured at Vavuniya, 20-xii-23; a male taken at Anuradhapura, 14-xii-16 (collector unknown); one male (type) and two females taken in close proximity at Marichchukaddi, N.P., 15-iii-33; one male 21-iii-33; two males (one immature) and a female, 25-iii-33, taken at Marai Villu beside the Wilpattu Game Sanctuary. They were found on jungle undergrowth by road-sides, etc., and did not seem to be confined to any particular food-plant. The last-mentioned female was ' rescued ' from a large, black Sphegid wasp which was unfortunately not captured.

The type with another male and a female will be presented to the British Museum (Natural History), on publication of this paper; the remaining paratypes are retained in the Colombo Museum.

It is possible that this may be merely a subspecies of *P.cristagalli* Bolivar (1902, p. 620), with the description of which it agrees fairly closely; the pronotum is, however, of a shape very different from Bolivar's figure, and in view of the inadequacy of his description I prefer to treat it as a full species.

Belonocnemis elegantulus Bolivar (1914, p. 33)

A male and 2 females of this fine species were captured by me at Randeniya Estate near Wellawaya, on 7-i-28, in park-like country with long grass. They are identified from Bolivar's description, with which the male agrees very closely, being merely a little larger. The following details of structure deserve notice: the maxillary and labial palps—especially the former—have their distal joint somewhat broadened and strongly compressed; the metasternal lobes in the

female are narrowly separated, not contiguous as in the male; the tegmina are narrow in the proximal half, broader distally, with the costal margin only slightly expanded near the base. The scapular and anterior axillary areas of the tegmina (including the first anal vein) are bright greenish yellow in the male. In the female the latter is castaneous except at the extreme base and the former is duller. There are scattered brownish-hyaline spots on the tegmina especially in the distal half. The wings in both sexes are pale, greenish-blue hyaline, with the veins proximally deeper blue, distally brown.

The female genitalia are closely similar in all respects to those of *Tylotropidius varicornis* (Walk.).

Measurements

	♂ mm.		♀ mm.		♀ mm.	
Length	35·0	...	61·0	...	54·0	
Length of antenna, approx. ...	16·0	...	18·5	...	18·5	
Width of head including eyes ...	4·8	...	6·7	...	6·7	
Length of pronotum ...	5·5	...	9·0	...	9·0	
Length of tegmen ...	27·5	...	43·0	...	?	(damaged)
Breadth of tegmen (a little distal to the middle) ...	4:2	...	7:0	...	?	
Length of hind femur ...	27·0	...	42·0	...	42·0	
Length of hind tibia (without spurs)	24·0	...	38·5	...	37·0	
Length of hind tarsus ...	11·0	...	14·0	...	14·0	

One female will be presented to the British Museum (Natural History), where, I believe, this species is at present unrepresented.

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EXPLANATION OF PLATES.

Plate XXVIII.

Fig. 1.	*Zygophlaeoba bolivari* sp. nov.	♀, dorsal × 3¾
Fig. 2.	Do.	♀, profile × 3¾
Fig. 3.	*Zygophlaeoba varicornis* sp. nov.	♂, dorsal × 3¾
Fig. 4.	Do.	♀, profile × 3¾
Fig. 5.	Do.	♀, front of head × 7

Plate XXIX.

Fig. 1.	*Babubuddinia dimorpha*, sp. nov.	♂, dorsal × 3
Fig. 2.	Do.	♀, profile × 3
Fig. 3.	Do.	♀, front of head × 6
Fig. 4.	Do.	♂, meso- and meta-sterna × 6
Fig. 5.	*Scintharista marshalli*, sp. nov.	♂, head and pronotum, dorsal × 3
Fig. 6.	Do.	♂ do. lateral × 3
Fig. 7.	Do.	♂, left tegmen and wing × 2

Plate XXX.

Fig. 1.	*Rakwana ornata*, gen. et sp. nov.	♂, dorsal × 3
Fig. 2.	Do.	♀, profile × 3
Fig. 3.	Do.	♀, head × 5
Fig. 4.	Do.	♀, meso- and meta-sterna × 4

Plate XXXI.

Fig. 1.	*Tarbaleus crassibrachiatus*, sp. nov.	♂, dorsal × 2
Fig. 2.	Do.	♂, meso- and meta-sterna × 3
Fig. 3.	*Tarbaleus gammaduensis*, sp. nov.	♂, dorsal × 2
Fig. 4.	Do.	♀, profile × 2

Plate XXXII.

Fig. 1.	*Eliya gibbosa*, sp. nov.	♀, dorsal × 3
Fig. 2.	Do.	♀, profile × 3
Fig. 3.	Do.	♀, face × 5
Fig. 4.	*Eliya venusta*, sp. nov.	♀, profile × 3
Fig. 5.	Do.	♂, dorsal × 3

Plate XXXIII.

Fig. 1.	*Cercina phillipsi*, sp. nov.	♂, dorsal × 4
Fig. 2.	Do.	♀, profile × 4

Plate XXXIV.

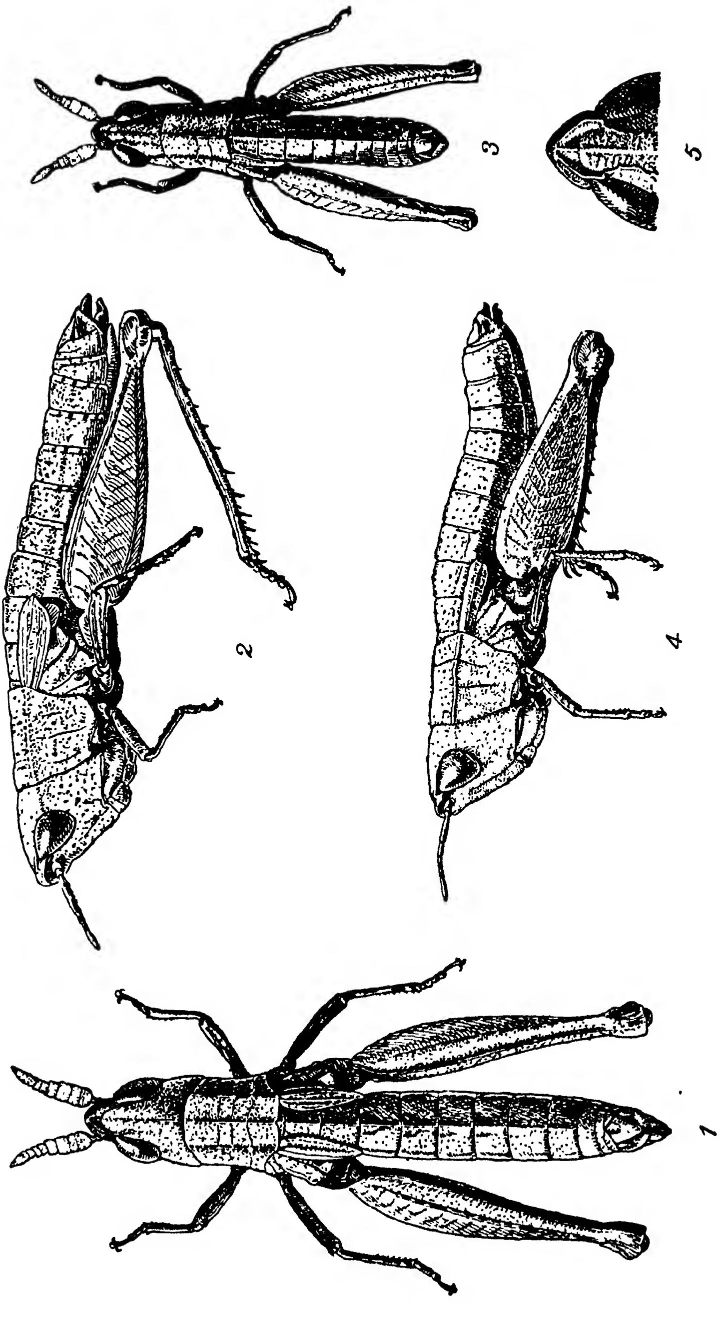
Fig. 1.	*Ochlandriphaga xanthelytrana*, gen et sp. nov.	♂, dorsal × 2½
Fig. 2.	Do.	♀, profile × 2½
Fig. 3.	Do.	♀, prosternal tubercle, posterior aspect × 9
Fig. 4.	Do.	♀, prosternal tubercle, lateral aspect × 9
Fig. 5.	Do.	♀, meso- and meta sterna × 3⅓

PLATE XXXV.

Fig. 1.	*Bambusacris greeni*, gen. et sp. nov.	♂, dorsal × 2½
Fig. 2.	Do.	♀, profile × 2½
Fig. 3.	Do.	♂, head, dorsal × 6½
Fig. 4.	Do.	♂, head, profile × 6½
Fig. 5.	Do.	♀, prosternal tubercle, × 15 A *posterior aspect.* B *left lateral aspect.*
Fig. 6.	Do.	♀, meso- and meta- sterna × 6½

PLATE XXXVI.

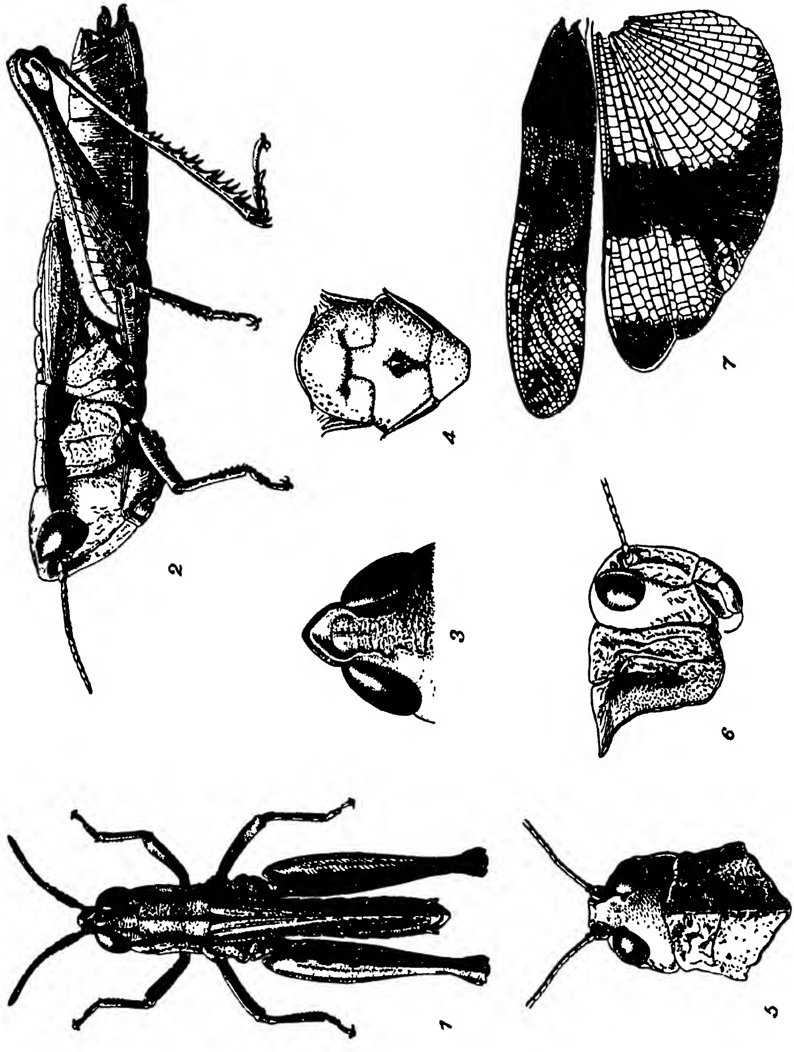
Fig. 1.	*Ischnacrida gracilis*, sp. nov.	♂, profile × 2½
Fig. 2.	Do.	♂, head and pronotum, dorsal × 6
Fig. 3.	Do.	♂, meso- and meta-sterna × 6
Fig. 4.	Do.	♂, genitalia, dorsal × 6
Fig. 5.	*Pelecinotus lankae*, sp. nov.	♂, profile × 3
Fig. 6.	Do.	♂, face × 4
Fig. 7.	Do.	♂, meso- and meta-sterna × 4



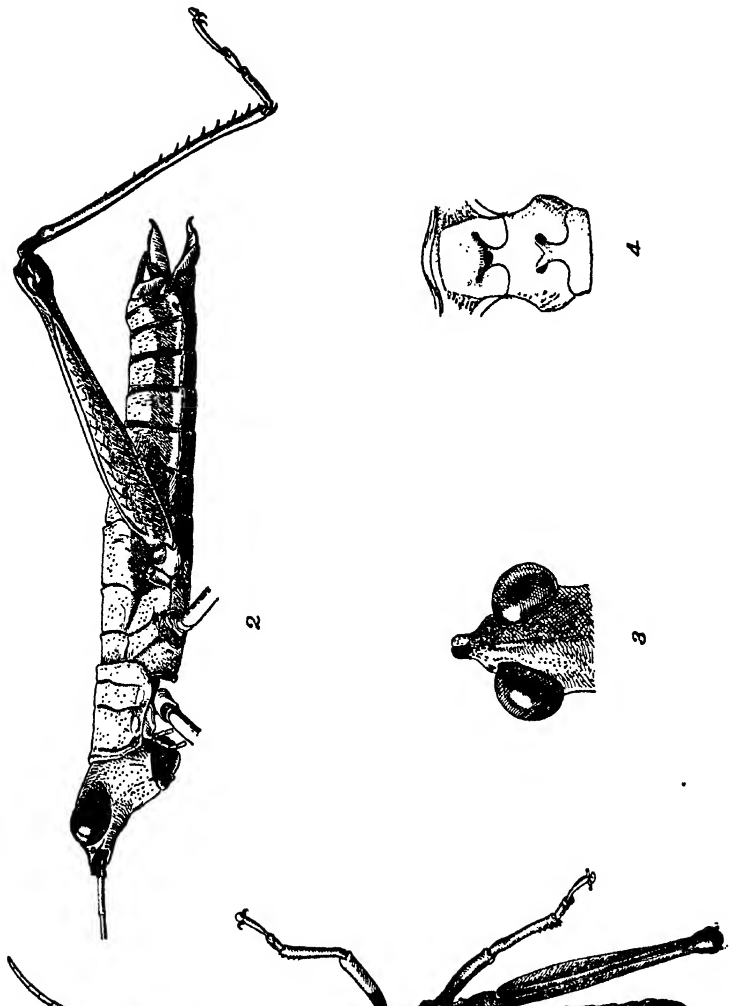
1, 2. *Zygophlaeoba bolivari*, sp. nov.

3, 5. *Zygophlacoba varicornis*, sp. nov.

G. Henry del.

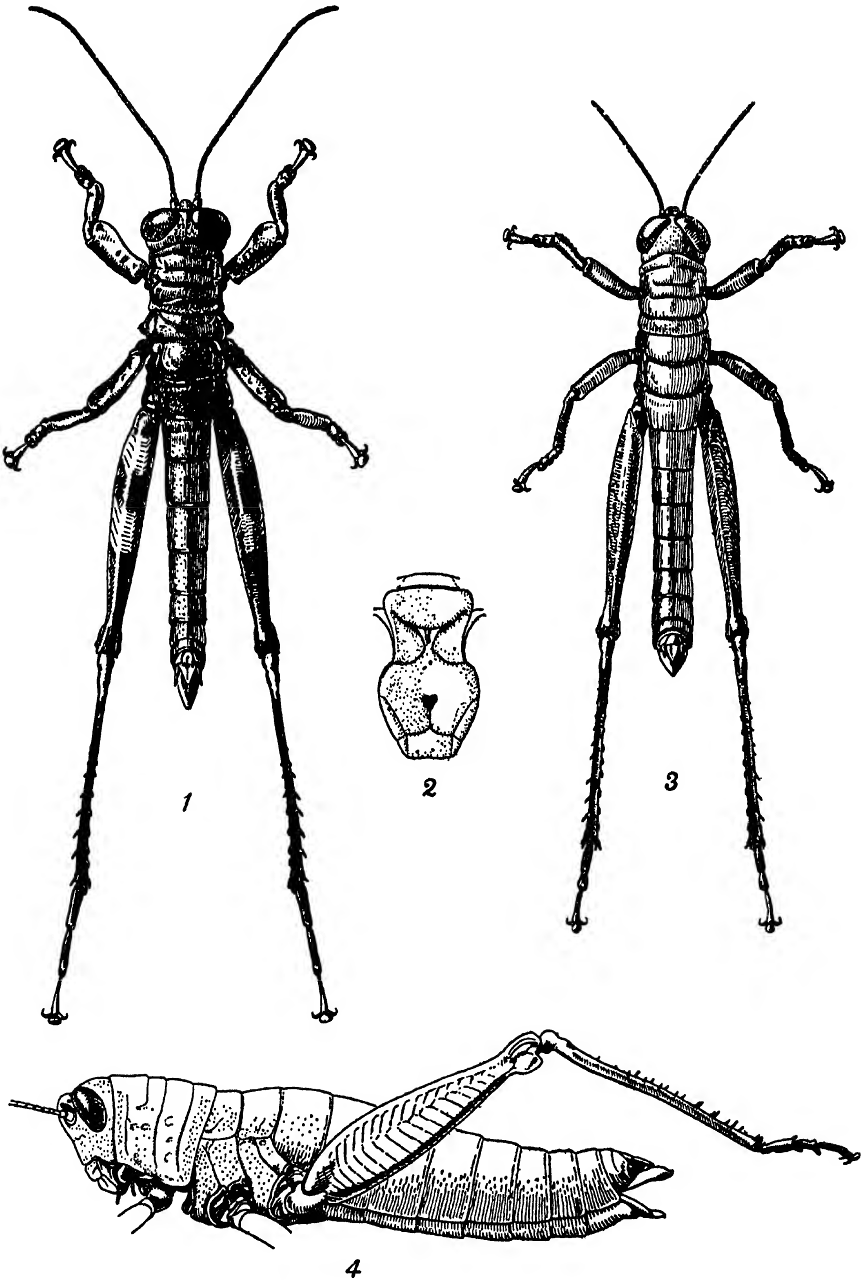


G. Henry del. 1-4. *Bababuddinia dimorpha*, sp. nov. 5-7. *Scintharista marshalli*, sp. nov.



Rakwana ornata, gen. et sp. nov.

G. Henry del.



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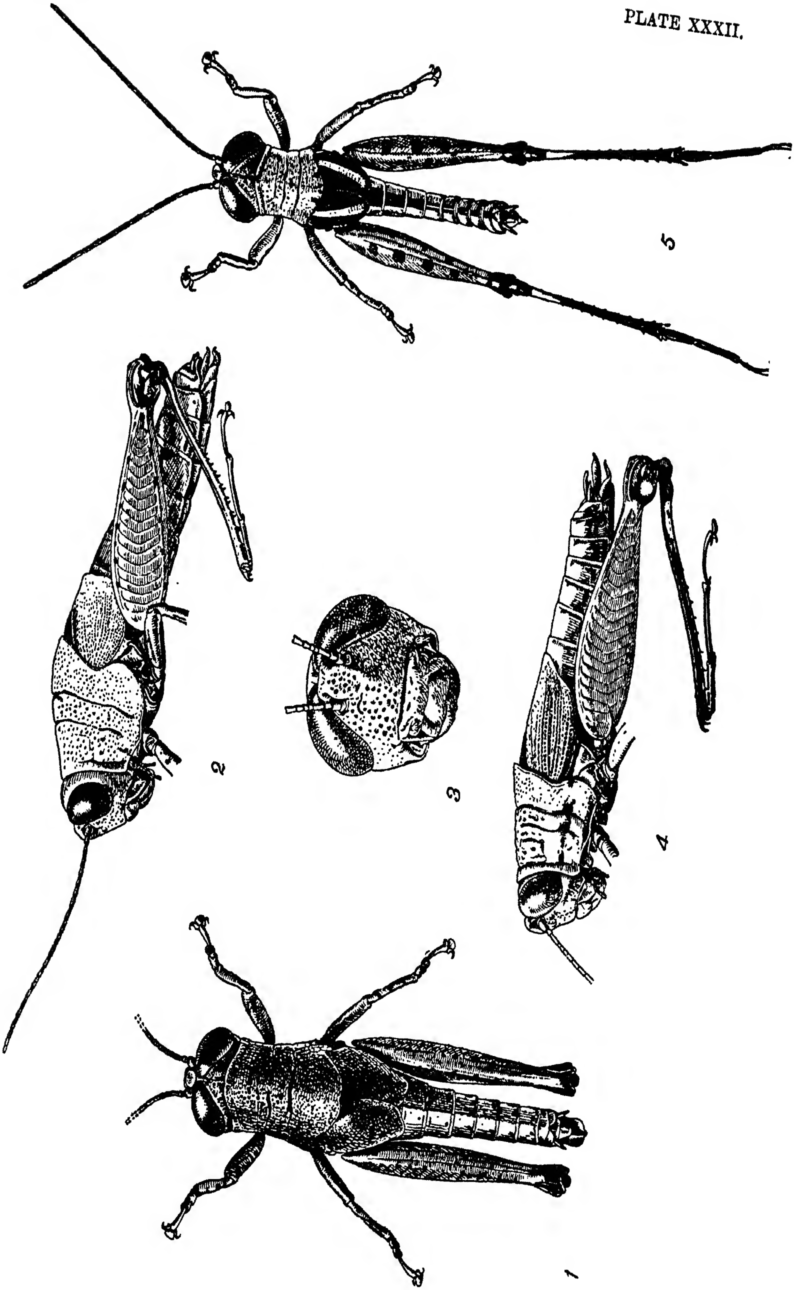
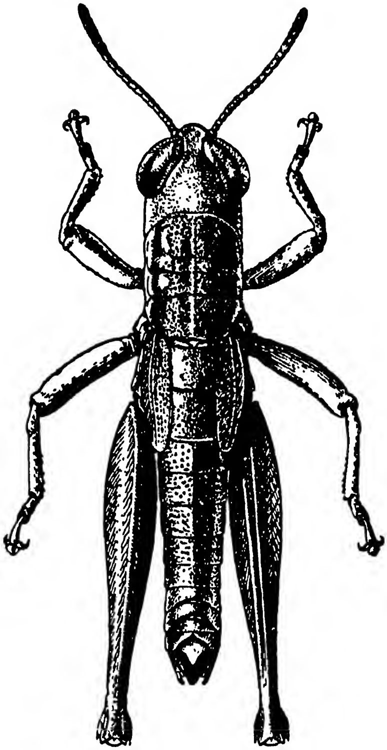
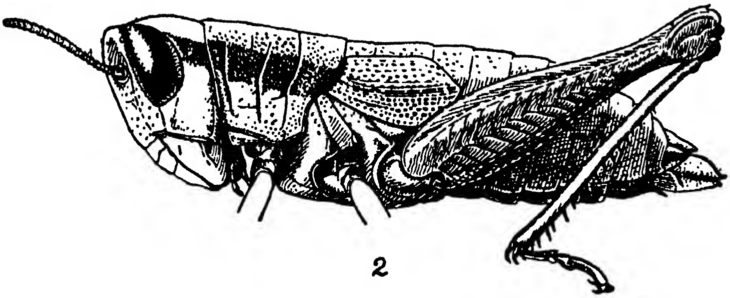
1, 2. *Tarbaleus crassibrachiatus*, sp. nov. 3, 4. *Tarbaleus gammaduensis*, sp. ı

PLATE XXXII.







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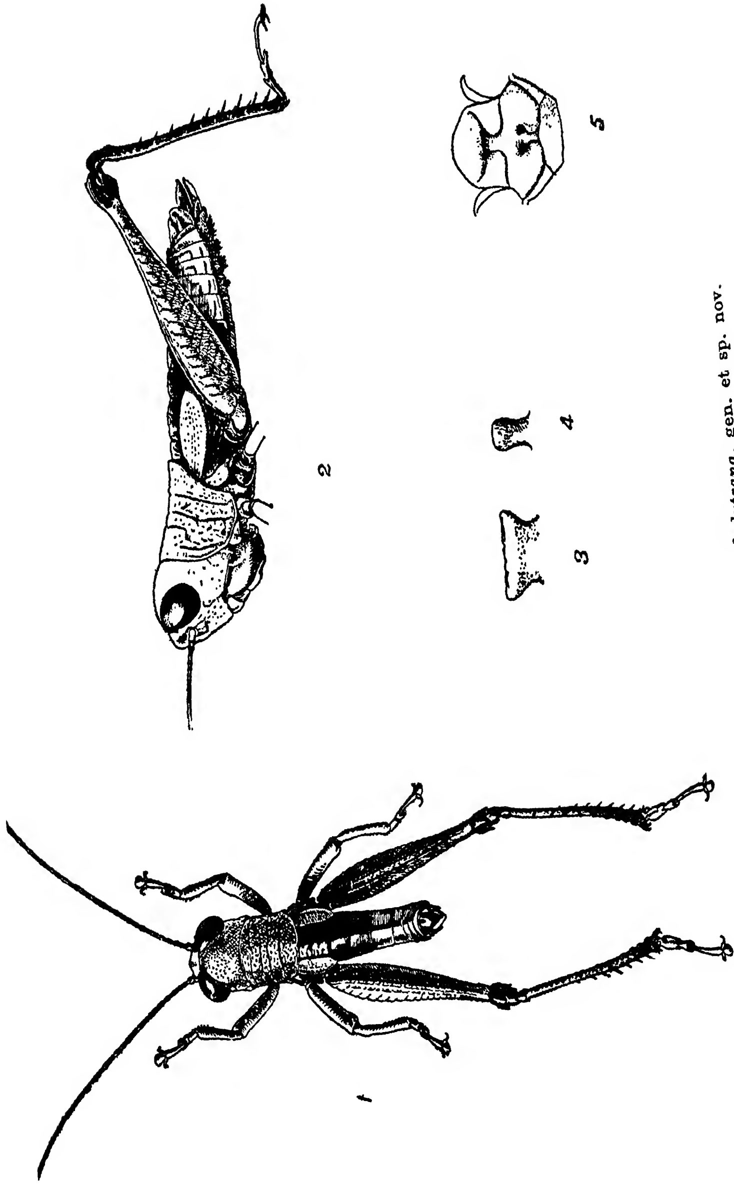
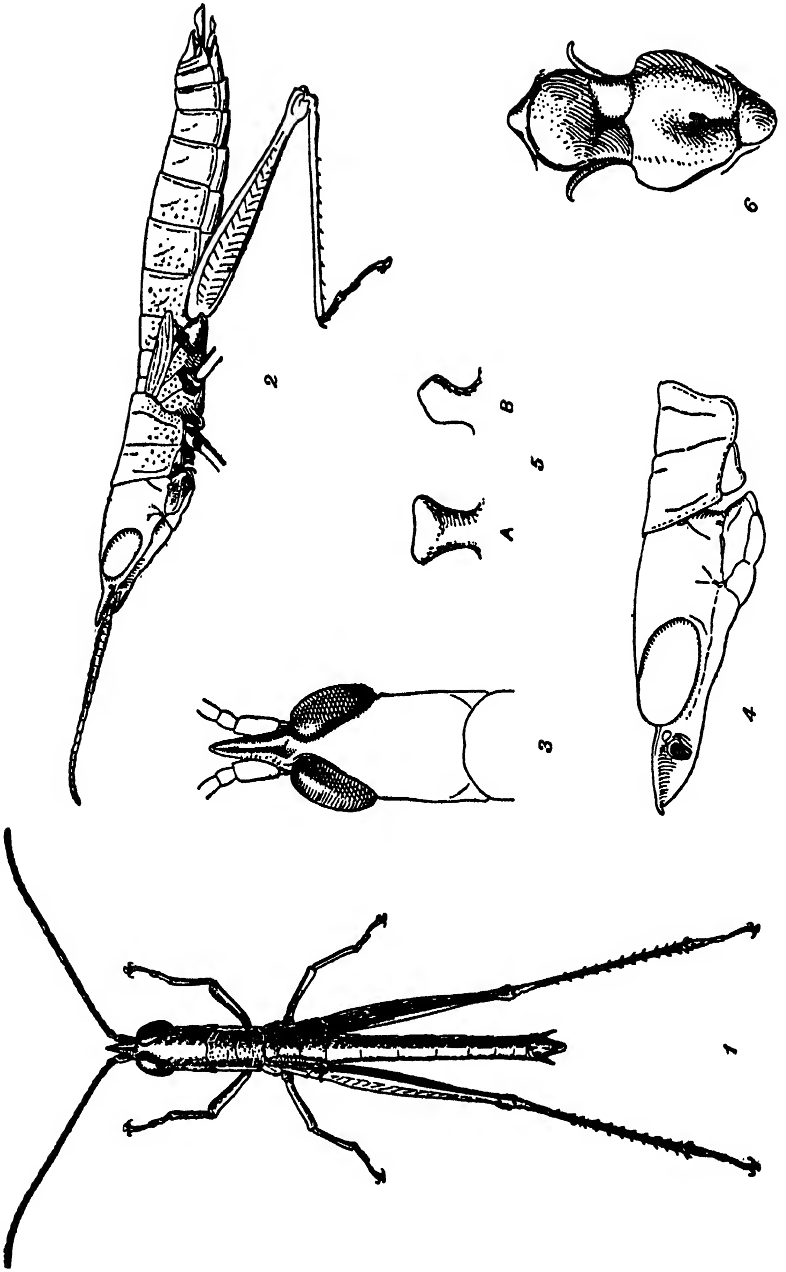
Cercina phillipsi, sp. nov.



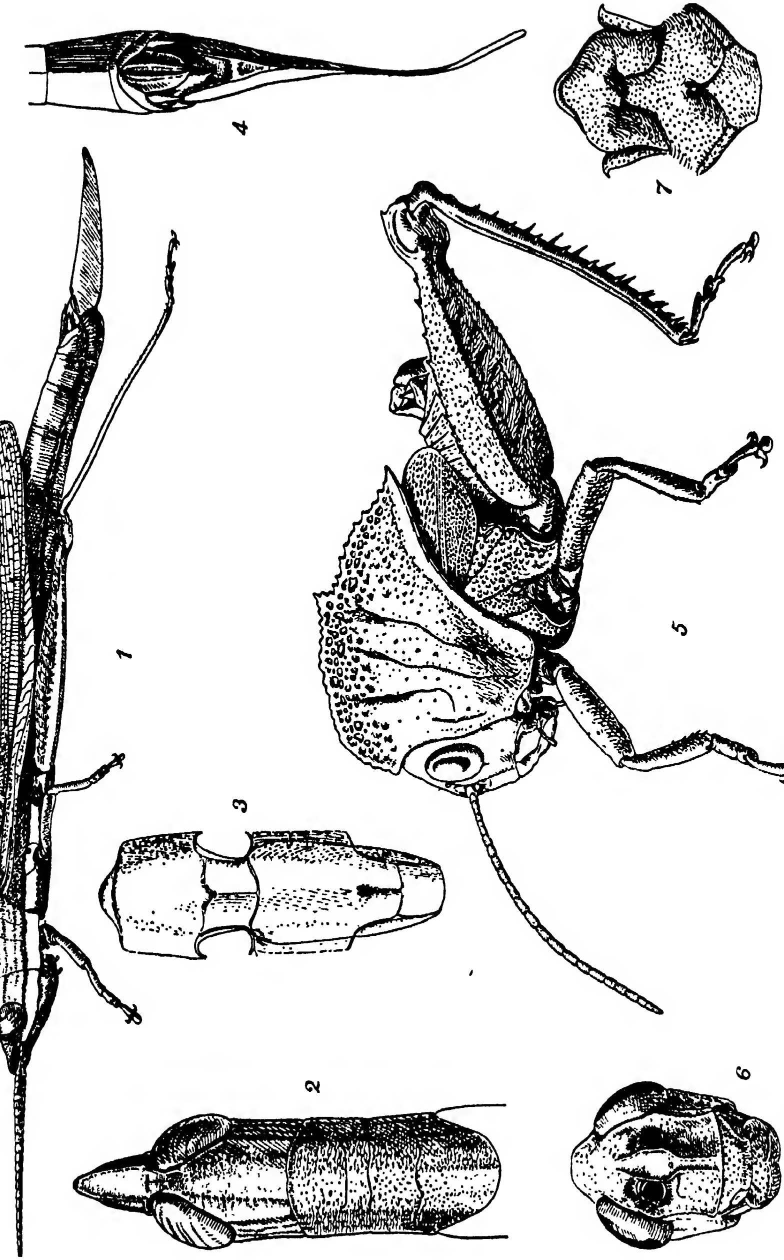
Ochlandriphaga xanthelytrana, gen. et sp. nov.

G. Henry del



Bambusacris greeni, gen. et sp. nov.

G. Henry del.



G. Henry del.

1-4. *Ishnacrida gracilis*, sp. nov.

5-7. *Pelecinotus lankae*, sp. nov.

CEYLON J. SCI. (B) VOL. XVII, PT. 3. (*May 19, 1933*)

The Platystictas of Ceylon (Order Odonata)

BY

F. C. FRASER, LT.-COL., I.M.S., F.E.S.

(With Thirteen Text Figures.)

In the months of May and June of 1932 I spent a short holiday in Ceylon with the express object of collecting and studying Odonata but more especially species of the genera *Platysticta* and *Ceylonosticta* Several obscure points relating to these insects needed clearing up and it seemed to me that this could only be done by making observations on the spot. My trip was carefully planned out, both as regards time, May and June being the two best months for collecting, and the localities to be visited. A list of all localities where species had been taken was compiled and a map made to include the whole of these. This touring map was carefully adhered to and all localities were visited save Passara and Madulsima.

The tour starting from Colombo ran viâ Kandy which place I made my headquarters for a week and from which I made expeditions to Ramboda, Haragama, Madugoda and Urugalla. From Kandy I went via Ramboda and Nuwara Eliya to Hakgalla and Bandarawela collecting en route. The latter place again became my headquarters from which collecting trips were made in various directions, but more particularly around Haputale and the ghat down to Belihul-oya, the latter proving very rich in dragonfly life. Return to Colombo was made viâ Belihul-oya, Balangoda and Ratnapura, collecting again being carried out en route.

Selys described one species of *Platysticta* and four of *Ceylonosticta*, the latter at that time being included under the former genus, and all of these came from Ramboda. Unfortunately I found this district completely changed; formerly a flourishing coffee district, it was now opened up under tea and with very little shade to speak of; jungles had been cleared and few retreats left where insects such as I was in search of could find suitable breeding places. With the exception of a few specimens of *P.maculata* and a solitary female of *C.hilaris*, I found all the rivers there destitute of Platystictine life.

Much more fortunate were my visits to Col. Yerbury's old hunting grounds. Here I had little difficulty in finding numerous colonies and in securing some 160 specimens. Both sexes of all the nine known species were discovered and three new species added to the list.

In addition to the material collected on this expedition I had the loan of nearly 50 specimens from the Colombo Museum due to the kindness of Dr. Pearson the Director and Mr. Henry the Assistant in Systematic Entomology, who gave me every assistance; to these two gentlemen I take this opportunity of expressing my thanks. From this latter material a number of new localities were added to my list, and it was also from this that I made the discovery that the adult of *P.maculata* Selys has the wings tipped with black as in *P.apicalis*. The specimens taken by myself at Ramboda were all teneral and had the wings completely hyaline as in the type.

The remainder of the material examined by myself included the collection in the British Museum and a few specimens collected by Col. F. Wall, I.M.S., in 1926, and now in my collection. In all about 250 specimens were examined, a sufficiently large number to permit of a revision of the two genera and to clear up all the obscure points which had been awaiting elucidation for long.

I have to thank Mr. D. E. Kimmins of the British Museum for kindly making a re-examination of the type of *P.apicalis*, as I suspected that adults of *P.maculata* had been included under that name. This proved to be correct, the Madulsima material collected by Mr. T. Bainbrigge Fletcher turning out to be *P.maculata*. My original figures of the anal appendages of *P.apicalis*, given in the Journal of the Bombay Natural History Society, had been made from these specimens under the impression that I was dealing with specimens of *P.apicalis* alone, thus these figures relate to two species, the dorsal view being that of *P.apicalis*, and the lateral to *P.maculata*. Kirby's type and allotype-female of *P.apicalis* had remained bracketed with specimens of *P.maculata* from Madulsima for a period of six years quite unnoticed, but the insects, apart from the differences in the anal appendages, are so remarkably similar that the mistake was excusable, especially as Selys had not mentioned that *P.maculata*, adult, had the wings also tipped with black. Kirby's original description does not do full justice to the remarkable character of the anal appendages of *P.apicalis*.

All the original descriptions of species were made from dried faded specimens and are so inaccurate, as applied to the living insect, that in most cases I have been compelled to give entirely new descriptions instead of merely pointing out the discrepancies. The living insects are of great beauty and little justice has been done to them in the old Selysian descriptions; the females of *C.digna* and *C.lankanensis* are two of the most beautiful insects found in the Order Odonata.

All species, before being killed, were carefully sketched and the living colours painted in, so that the greatest possible measure of accuracy in description might be obtained. The figures of the anal appendages have all been made from camera lucida studies drawn to the same scale.

It remains to be pointed out that the figures given in the Journ. Bom. Nat. Hist. Soc., Vol. XXXV, Plate 1 (opposite p. 327), figs I and II are those of *C.subtropica;* at the time of sketching these, only one species with the prothorax possessing stalked processes was known, so that this species was taken to be it, viz., *C.tropica* (Selys). Figure V in the same plate is the right lateral view of the anal appendages of *P.maculata* and not *P.apicalis*, whilst figure XI is a very poor one of *C.montana* made from a teneral, compressed specimen, the only one available at the time

Key to the Ceylon Platystictas

1. Large species (Hindwing 30 mm or over). Wings tipped with black; sectors of arc arising separately and divergent from origin; *IRiii* and *MA* zigzagged from near origin ...	*Platysticta*	2.
Smaller species (Hindwing 25 mm or under). Wings not tipped with black; sectors of arc arising from a common stalk; *IRiii* and *MA* not zigzagged from near origin ...	*Ceylonosticta*	3.
2. Inferior anal appendages ending in a robust upturned, staple-like hoop; female with a black dumb-bell-shaped middorsal stripe on segment 9	*P.apicalis* Kirby.	
Inferior anal appendages ending in a fine incurved spine; female with the base and sides of segment 9 black	***P.maculata*** **Selys.**	
3. The nervure *Riv + v* arising proximad of the nervure descending from the node ...	*Ceylonosticta* Group I,	4.
The nervure *Riv + v* arising from or a little distad to the nervure descending from the node	*Ceylonosticta* Group II,	8.

Ceylonosticta Group I

4. Anterior lobe of prothorax with long stalked processes	...	5.
Anterior lobe of prothorax without long stalked processes	...	6.
5. Labrum blue, not bordered with black; prothorax blackish brown	*C.tropica* (Selys.)	
Labrum blue bordered with black; prothorax with anterior and middle lobes blue, the posterior lobe only blackish brown ...	*C.subtropica* sp. nov.	
6. A reddish brown area on vertex and occiput; an obtuse spine on upper border of superior anal appendages	...	7.
Vertex and occiput entirely black; no spine on upper border of superior anal appendages ...	*C.adami* sp. nov.	
7. Labrum not bordered with black; inferior anal appendages ending in a tiny sickle-shaped hook	*C.montana* (Selys.)	
Labrum bordered with black; inferior anal appendages ending in a fine, simple inturned spine	*C.submontana* sp. nov.	

Ceylonosticta Group II

8.	Middorsum of synthorax narrowly azure blue ...	...	9.
	Middorsum of synthorax bronzed dark brown ...	...	10.
9.	Inferior anal appendages very obtuse and truncate at apex and with a very robust spine at the middle of inner border directed straight inward	*C.digna* (Selys.)	
	Inferior anal appendages without an inner spine, the apex expanded, subtrilobate ...	*C.nietneri* Fraser.	
10.	Thorax black beneath; posterior lobe of prothorax prolonged medially ...	*C.walli* Fraser.	
	Thorax yellowish beneath; posterior lobe of prothorax broadly rounded behind ...	...	11.
11.	Prothorax entirely blackish brown ...	*C.lankanensis* Fraser.	
	Prothorax pale azure blue, the posterior lobe only dark chocolate brown	*C.hilaris* (Selys.)	

Platysticta maculata Selys

Male. Abdomen 47-51 mm. Hindwing 32-36 mm.

Head: labium blackish brown, pale at base; labrum, bases of mandibles and anteclypeus turquoise blue, the former variably bordered with black, this sometimes almost obscuring the blue at base or encroaching on it at the middle; eyes dark brown.

Prothorax with posterior lobe and the middle portion of the posterior half of middle lobe black, remainder pale blue or the anterior aspect of the anterior lobe may be black.

Thorax steely blue black as far lateral as the antero-lateral suture, anterior half of mesepimeron with an oblique pale blue stripe, posterior half steely blue black, metepimeron pale blue, yellow beneath thorax. Legs blackish brown, trochanters and coxae pale blue, proximal ends of femora pale brown.

Wings hyaline in tenerals, apices tipped with blackish brown in adults as far proximal as the inner end of pterostigma; the latter dark reddish brown framed very finely in ochreous, covering 1 or 2 cells, usually 2 cells, about one-fourth longer than broad; 19 to 25 postnodal nervures in forewings, 19 to 21 in the hind; *Riv* + *v* arising well proximal of the nervure descending from the node, *IRiii* at the level of that nervure.

Abdomen steely black on dorsum and sides except the ventral border which is narrowly yellow; segments 1 and 2 more broadly bluish laterally, segments 3 to 7 with narrow basal yellow annules almost obsolete in the adult; segment 8 blue on dorsum, this blue area tapering towards the base but not quite extending to it; dorsum of segments 9 and 10 azure blue.

Anal appendages: superiors black, twice as long as segment 10, broad at base, then constricted and again broadly and abruptly dilated at the apical half, which part is strongly angulated inwards and downwards

to meet the appendage from the opposite side. Inferiors considerably shorter, very broad and somewhat quadrate at base where they present an inner subbasal spine directed somewhat upwards,, the apical portion slim as seen from the side but broad and hollowed out within as seen from above and with the extreme apex turned sharply in and a little upwards.

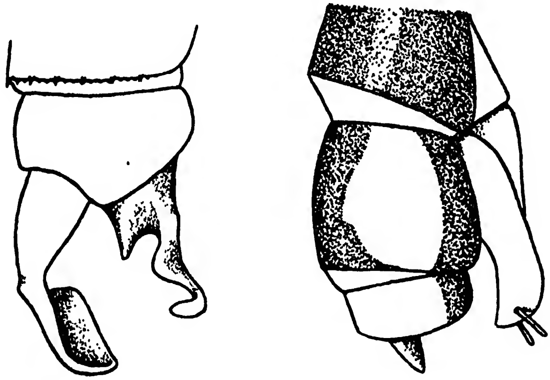


Fig. 1. *Platysticta maculata* Selys.

A. Anal appendages of ♂, seen from the right side.
B. End segments of ♀ to show blue markings on segment 9 and 10.

Female. Abdomen 36-45 mm. Hindwing 29-34 mm.

Very similar to the male but a shorter, stouter insect and showing more variation in size. Segment 9 with the dorsum of apical half azure blue, this blue area extending back along the middorsum as a tapering point as far as the base of segment and its borders also prolonged back as short points basad.

Wings similar to the male but pterostigma always covering only 1 cell; 23 postnodal nervures to forewings, 20 in the hind; apices of wings in adult specimens golden amber enfumed with brown.

Habitat.—The type in the Hagen collection is from Ramboda where I found the insect rather scarce during May, but it was then only emerging and might have become common later on. Mr. T. B. Fletcher took specimens at Madulsima during August, these all being adult and the actual ones which I had formerly confused with *P.apicalis*. Mr. Henry has taken it at Kitulgalla as early as April.

The insect when resting and on the wing is quite indistinguishable from the latter species and closely resembles *Phylloneura westermanni* (Selys). On the average it is a smaller insect than *P.apicalis*, the larger specimens of *P.maculata* equalling the smallest of the former. They are easily distinguished by the entirely different shape of the

inferior anal appendages and the females may be as easily distinguished by the entirely different markings on segment 9. Type and allotype in the Hagen collection, paratypes in the British Museum, Colombo Museum and my own collection.

Platysticta apicalis Kirby

Male. Abdomen 52-58 mm. Hindwing 37-42 mm.

Closely resembles *P.maculata*, differing from it in the following respects.—Prothorax pale blue save for the posterior lobe which is black. A small black triangular spot on the upper posterior part of metepimeron and a tiny point at the extreme posterior corner thereof.

Wings hyaline in tenerals, apices tipped with blackish brown in adults as in *P.maculata;* in very old specimens, the wings for a variable area proximal to the black portion are opalescent or lacteous; 21-23 postnodal nervures in forewings, 19-22 in the hind; pterostigma dark reddish brown finely framed in ochreous, nearly twice as long as broad, covering only 1 cell, very rarely 2.

Abdomen with segments 8 to 10 azure blue on dorsum, the former segment with a narrow black basal annule prolonged slightly apicad along the middorsum.

Anal appendages black; superiors exactly similar to those of *P.maculata;* inferiors about one-third shorter, very broad and somewhat conical at base and furnished with a very robust spine on the inner side directed slightly upwards, the appendage then abruptly tapered, slightly sinuous and ending in a robust strongly curled staple-like hook, the hollow of which looks upwards.

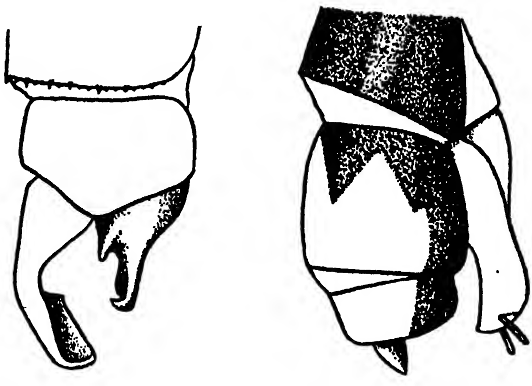


Fig. 2. *Platysticta apicalis* Kirby.

A. Anal appendages of ♂, seen from the right side.
B. End segments of ♀, to show blue markings on segments 9 and 10.

Female. Abdomen 37-40 mm. Hindwing 45-46 mm.

Closely similar to the female of *P.maculata*, differing only by its larger size and the markings on segment 9, which latter is broadly azure blue on dorsum and subdorsum and with a broad black middorsal, dumbbell-shaped stripe extending from base to apical border of segment. Wings in adults tipped with bright amber enfumed with burnt brown but never quite opaque. Anal appendages very short, conical, blackish brown; vulvar scale brown, paler at apex, extending to end of abdomen.

Habitat.—Belihul-oya, where I found it exceedingly common during May and June, Haldummulla and Rakwana. Those seen early in May were teneral and had no trace of the black apical marking on the wings, but a few days later these began to appear and by June almost all specimens would have this fully developed. Unlike the smaller members of the group, these insects take to trees, and specimens were sometimes seen resting as high as fifteen feet off the ground, although they preferred a lesser height; flight is rather weak and they never come out into the open. The distinguishing features from *P.maculata* are given under the description of that insect. Type in the British Museum, paratypes in the Colombo Museum and my own collections.

Ceylonosticta tropica (Selys)

Male. Abdomen 41-42 mm. Hindwing 26-26.5 mm.

Head: labium pale yellowish brown; labrum, anteclypeus and bases of mandibles palest turquoise blue, the former with or without an obscure pale brownish bordering; rest of head bronzed black; eyes blue with a broad equatorial band of brown; second segment of antennae yellow.

Prothorax dark reddish brown, the posterior lobe bronzed blackish brown, the anterior lobe with a pair of elongated stalked yellow processes clubbed at the extremities.

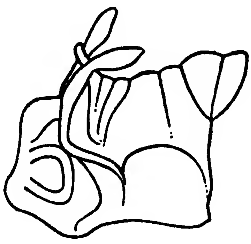


Fig. 8. *Ceylonosticta tropica* (Selys).

Prothorax of ♂ to show processes on anterior lobe.

Abdomen reddish brown marked with yellow and blue as follows.—segment 1 entirely yellow save for a brown apical annule; segment 2 with a broad elongate spot on each side covering the anterior two thirds; segment 3 with a very narrow basal annule interrupted on the dorsum; segments 4 to 7 similar but the basal annules broader and the ground colour becoming darker, so that the apical dark annules gradually blend into it; segment 8 black with only its apical joint blue; segments 9 and 10 entirely azure blue on dorsum and subdorsum, black on the sides.

Anal appendages; superiors twice as long as segment 10, brown, broad at base, twisted on the long axis so that the outer side comes to look upwards in the apical half of appendage; the apical half broadly and abruptly expanded, its inner lower angle forming almost a stout spine directed downward and inward as seen from the dorsum. No upper spine on the border of appendages; apices curling gently in and meeting as seen from above. Inferiors about three quarters the length of superiors, broad and conical at extreme base which has an inner robust spine, then remarkably attenuated, almost hair-like as far as apex, which is acuminate.

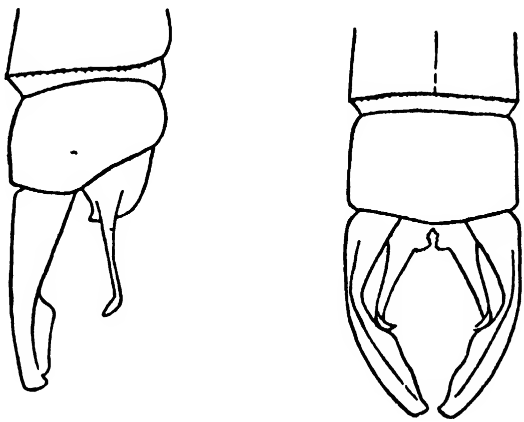


Fig. 5. *Ceylonosticta subtropica*, sp. nov.

Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 36 mm. Hindwing 26 mm.

Very similar to the male but a shorter, stouter and more robust insect; wings with 16 postnodal nervures in the fore and 15 in the hind, palely enfumed; abdominal segments 9 and 10 and the apical joint of segment 8 pale azure blue. Anal appendages dark brown, short and conical; vulvar scales robust, extending to end of abdomen.

Habitat.—Balangoda and Pettiagalla, Ceylon, during May and June. Closely related to *C.tropica* by the curious processes on the anterior lobe of prothorax but differing from it by the middle lobe of prothorax blue, labrum bordered with black and the hair-like thinness of the inferior anal appendages.

Ceylonosticta adami, sp. nov.

Male. Abdomen 37-41 mm. Hindwing 24-25 mm.

Head: labium creamy yellow to palest brown; labrum, bases of mandibles and anteclypeus glossy white palely tinted with blue, the former narrowly bordered with black; rest of head mat black; eyes bright blue with an equatorial band of bright reddish brown.

Prothorax with middle lobe pale blue, anterior and posterior lobes bronzed black, the former without stalked processes, the latter rounded and paler at the outer ends.

Thorax bronzed black on dorsum as far lateral as the antero-lateral suture, beyond which the sides are pale blue with a bronzed black stripe on the mesepimeron tapering below; pale yellow beneath without black markings.

Legs pale yellow, tibiae and tarsi darker, femora with a fine black line on the outer sides.

Wings hyaline; pterostigma slightly longer than broad, with costal side much shorter than posterior, distal side rounded, proximal very oblique, covering 1 cell, dark reddish brown finely framed in paler brown; 15 to 16 postnodal nervures in forewings, 14 in the hind; *Riv + v* arising well proximal of the nervure descending from the node, *IRiii* at or a little distal to that level.

Abdomen bronzed blackish brown; segment 1 broadly blue at base and sides; segment 2 broadly blue on the sides; segments 3 to 8 with narrow creamy white basal annules, nearly interrupted on the dorsum of segment 3; segment 8 with its intersegmental joint blue or occasionally with a triangular blue dorsal apical spot covering about one third of the segment, segments 9 and 10 with the whole dorsum azure blue.

Anal appendages; superiors black, about twice as long as segment 10, broad at base, compressed laterally, twisted on the long axis so that the outer side comes to look upward in the apical half, curved gently in towards one another so that the apices nearly meet, the apical half rather abruptly expanded and angulated rather strongly downward and inward, no spine at this angulation. Inferiors pale

brown, of the same length as superiors, very broad at base which is a quadrate plate forming rather more than one third of the appendage and bearing an obtuse spine at the inner angle, then abruptly and markedly attenuated and somewhat sinuous as far as apex which is expanded into a small spoon-shaped lobe.

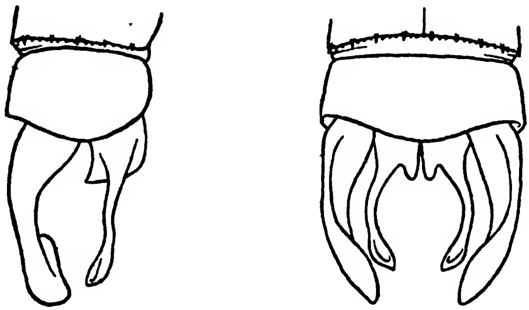


Fig. 6. *Ceylonosticta adami*, sp. nov.

Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 34 mm. Hindwing 24 mm.

A shorter stouter insect than the male; the basal annules on segments 3 to 8 much broader and more conspicuously blue; segment 8 with only the following joint blue; segment 9 with the blue diffusing into black at base, whilst 10 is entirely blue on dorsum. Anal appendages black, short, conical; vulvar scales robust, extending to extreme end of abdomen. *Riv + v* well proximal of the oblique nervure descending from the node, *IRiii* arising at the level of that nervure; 14 postnodal nervures in forewings, 13 in the hind.

Habitat.—Madugoda near Urugalla, Ceylon. One female and 7 males taken on 5-v-32. A male was observed hiding in maiden-hair fern in a small cleft in the hill-side through which a trickle of water fell. The hill above was densely clothed in jungle but forcing my way up through this, in deep twilight I found the males along the course of the seepage, visible only by the blue identification area on the end of the abdomen. No ray of sunlight penetrated this stygian gloom and if it had not been for the betraying, perambulating, blue spot, it would have been impossible to see the insects. On return to the road, I found that my bearer had secured a female on the jungle side.

This species is easily distinguished from all others of the genus by the characteristic spoon-shaped dilatation of the apices of the inferior appendages. The blue median lobe sharply contrasted with the other lobes of the prothorax will also help in identification.

Ceylonosticta montana (Selys)

Male. Abdomen 41-43 mm. Hindwing 26-28 mm.

Head: labium dirty yellow; labrum, bases of mandibles and anteclypeus pale glossy turquoise blue, the former narrowly pale ochreous or palest brown along anterior border; rest of head bronzed black except for a quadrate area on vertex and front of occiput which is warm reddish or chocolate brown; eyes blue with a broad equatorial belt of bright brick red or light reddish brown.

Prothorax uniform dark brown; posterior lobe rounded, rather deep; anterior lobe without stalked processes.

Thorax dark bronzed blackish brown on dorsum and sides save for a narrow largely obscured blue stripe on mesepimeron; metepimeron and beneath creamy yellow without black spots.

Legs yellowish, femora with an ill-defined black line on the outer sides, the distal ends black.

Wings hyaline; pterostigma brown framed narrowly in paler brown or white, distal side rounded, proximal very oblique, costal side much shorter than posterior, covering 1 cell; *Riv+v* arising well proximal of the level of the oblique nervure descending from the node, *IRiii* distal of that level; 15 to 17 postnodal nervures in forewings, 15 to 16 in the hind.

Abdomen black, the sides of segments 1 and 2 yellowish or pale blue; segment 3 with a basal white spot on each side; segments 4 to 7 with rather narrow basal white annules; segment 8 with only the intersegmental joint blue but occasionally with a small triangular apical blue spot on dorsum; segments 9 and 10 broadly blue on dorsum from base to apex, the sides black.

Anal appendages; superiors about twice as long as segment 10, broad at base, twisted on the long axis so that the outer side in the apical half comes to look upwards, this part abruptly and broadly expanded. At the junction of the stem and the broad apical portion, a large obtusely pointed tooth projecting upwards and inwards from the upper border. Seen from the dorsum, the appendages gently curved in towards one another so that the apices nearly meet. Inferior appendages of nearly the same length as superiors, broad and quadrate in the basal two-fifths and with the inner border ending in a sharp spine; the apical three-fifths very narrow, curved slightly out and ending in a small inwardly directed hook-like spine. Seen from the side, the

basal portion cone-shaped and ending in a spine, the narrow sinuous apical stem extending from the side of this and ending in a sickle-shaped, upwardly and inwardly directed hook.

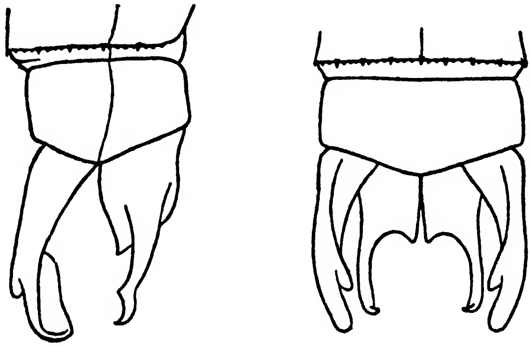


Fig. 7. *Ceylonosticta montana* (Selys).
Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 37-40 mm. Hindwing 26-28 mm.

Very similar to the male but the stripe on the sides of thorax broader and more conspicuous, the abdomen shorter and stouter and more cylindrical; basal annules on segments 4 to 7 azure blue and much broader than in the male; segment 8 unmarked; segment 9 with the greater part of dorsum azure blue but this portion vignetted into black at base of segment; segment 10 entirely blue on dorsum.

Anal appendages pale brown, very short, conical; vulvar scale very robust, extending to end of abdomen, dark brown.

Habitat.—Locality from which the type came unknown; I rediscovered this species on a small mountain brook in dense jungle and tree fern a short distance below Haputale on the Ratnapura road. Here I took 6 males and 2 females and could have taken more but they were just emerging and were nearly all soft and teneral and quite useless for specimens. As they emerged they appeared to ascend the hill-sides working their way up through the dense matted thicket or hinding up beneath the fronds of trees ferns. Hardly a ray or sun penetrated this damp, precipitous jungly water-course which was swarming with leeches, but it was typical of localities in which *Platysticta* was invariably found.

Ceylonosticta submontana, sp. nov.

Male. Abdomen 40-42 mm. Hindwing 24-26 mm.

Head: labium pale brown; labrum, bases of mandibles and anteclypeus pale turquoise blue, almost white, the former broadly bordered

with glossy black; rest of head bronzed black but the hinder part of vertex and adjacent part of occiput warm reddish brown at the middle; eyes blue with a broad equatorial belt of dark brown.

Prothorax uniform dark chocolate brown; anterior lobe without stalked processes; posterior lobe broadly rounded.

Thorax bronzed black on dorsum changing to dark chocolate brown on the sides as far as the antero-lateral suture; a broad pale blue oblique stripe on the anterior half of mesepimeron which is again chocolate brown in the posterior half; metepimeron violaceous brown, beneath yellow. Legs yellowish, the distal ends of femora darker.

Wings hyaline, palely enfumed brown; pterostigma dark reddish brown framed narrowly in ochreous, nearly quadrate, but slightly longer than broad, covering 1 cell; 14 to 17 postnodal nervures in fore-wings, 13 to 16 in the hind; *Riv* + *v* arising slightly proximal to the oblique nervure descending from the node, *IRiii* arising distad of that level.

Abdomen blackish brown marked with yellow and blue as follows:— Segment 1 with a small baso-lateral spot; segment 2 with a short oval latero-basal spot of yellow; segment 3 with a very narrow blue or pale yellow basal annule; segments 4 to 7 with much broader blue basal annules; segment 8 black with an apical blue dorsal triangular spot; segments 9 and 10 entirely blue on dorsum, laterally black.

Anal appendages: superiors twice as long as segment 10, forcipated as seen from the dorsum and rather sharply angulated inwards and downwards at their middles, at which point, on the superior border is seen a robust obtuse tooth; broad at base, broadly dilated in rather less than the apical half. Inferiors of nearly the same length, very broad and somewhat conical at base and presenting an inner spine, then rapidly tapered, somewhat sinuous, attenuated and ending in a tiny inturned hook.

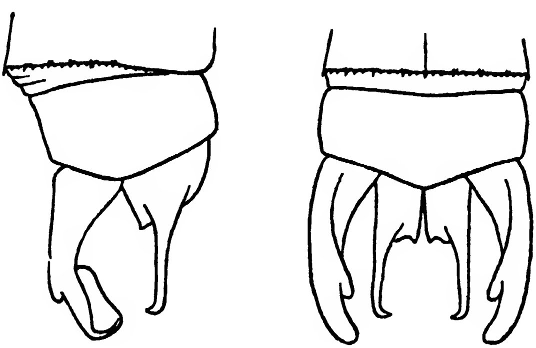


Fig. 8. *Ceylonosticta submontana*, sp. nov.
Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 38 mm. Hindwing 27 mm.

A much more robust and stouter insect than the male but coloured very similarly; the basal annules on segments 3 to 7 much broader and more conspicuous; segments 9 and 10 blue on dorsum; anal appendages very short, conical, dark brown; vulvar scales dark brown, very robust, extending beyond end of abdomen.

Habitat.—Kandy, 2000 feet, Ceylon. A single pair in my own collection secured by Col. F. Wall, I.M.S., during September. Closely related to *C.montana* by the superior tooth on the superior anal appendages and by the chocolate coloured patch on vertex and occiput, a feature shared by no others of the genus. Distinguished easily from *C.montana* by the broad black bordering to labrum and the shape of the inferior anal appendages.

Ceylonosticta hilaris (Selys)

Male. Abdomen 40-43 mm. Hindwing 25-27 mm.

Head: labium yellow tipped with brownish; labrum, bases of mandibles and anteclypeus pale turquoise blue, the former very broadly bordered with glossy black; rest of head bronzed black; eyes blue with an equatorial belt of dark brown.

Prothorax pale blue, the posterior lobe bronzed blackish brown, broadly rounded, its hinder border raised.

Thorax bronzed black as far lateral as the antero-lateral suture beyond which the mesepimeron is pale blue for its anterior half and bronzed dark brown for the posterior half; metepimeron pale blue or yellow, beneath yellow. Legs yellow clouded with reddish brown, distal ends of femora darker.

Wings hyaline, palely enfumed; pterostigma nearly twice as long as broad, dark reddish brown finely framed in yellow, covering 1 cell; 14 to 15 postnodal nervures in forewings, 14 in the hind; *Riv+v* arising in continuation of the nervure descending from the node, *IRiii* a little distal to the line of that nervure.

Abdomen bronzed brown; segments 1 and 2 broadly yellow on the sides, segment 3 with a very narrow basal annule; segments 4 to 7 with broader bluish basal annules which may be interrupted on the dorsum; segment 8 with a transverse oval blue apical spot; segments 9 and 10 azure blue on dorsum and subdorsum, black on the sides.

Anal appendages; superiors twice the length of segment 10, broad at base, then constricted slightly and again abruptly broadened in the apical half which part is rather strongly angulated inwards and downwards and presents, at the point of angulation above, an obtuse tooth.

Inferiors nearly as long as superiors, very broad at base which has an inner spine, then rather abruptly attenuated, cylindrical, directed straight back and ending in a small inwardly curved hook.

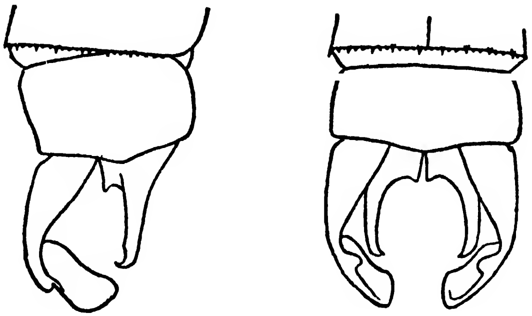


Fig. 9. *Ceylonosticta hilaris* (Selys).
Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 32-36 mm. Hindwing 24-25 mm.

A stouter shorter insect than the male which it greatly resembles however in its colour and markings. The pterostigma shorter, about half as long again as broad; venation similar to the male. Basal annules on segments 4 to 7 much broader and more conspicuous; segment 8 with only its apical joint blue, segments 9 and 10 blue on dorsum. Anal appendages short, conical, dark brown; vulvar scales very robust, extending beyond end of abdomen.

Habitat.—The type in the Hagen collection was found at Ramboda where I also took a single female in the month of May. A male was secured at Balangoda so that this species appears to occur in widely scattered colonies. The female was found in scrub jungle beside the major stream at Ramboda, in company with *P. maculata*.

Ceylonosticta nietneri Fraser

The colour and markings of the living insect differ in several respects from the original description of the male, but the description of the female is substantially correct.

Male. Abdomen 31-36 mm. Hindwing 20-22 mm.

Head: labrum narrowly bordered with reddish brown; eyes azure blue with a broad equatorial belt of brick-red.

Prothorax carneous with the whole of the posterior lobe and two rounded spots on the middorsum of middle lobe azure blue.

Thorax bright brick-red with a narrow middorsal carinal stripe of pale azure blue and a narrow similarly coloured oblique stripe on each side at middle of mesepimeron, this stripe ending in an oval pale carneous spot below, the blue partially encircling it above; posterior to this stripe the sides paler red whilst beneath thorax is carneous. Legs yellow faintly marked or suffused with brownish.

Wings: 13 to 15 postnodal nervures in forewings, 12 to 14 in the hind; *Riv + v* usually arising in continuation of the nervure descending from the node, *IRiii* well distad of that level, but quite occasionally both nervures arise distad of the nodal nervure.

Abdomen dark reddish brown or brick-red deepening rather abruptly to blackish brown at apical ends of segments and giving place to white annules at bases of same segments, the white annules spotted with azure blue at extreme base. The remaining segments as given in the original description.

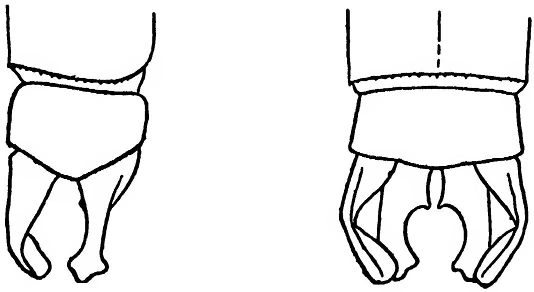


Fig. 10. *Ceylonosticta nietneri* Fraser.
Anal appendages of ♂, right lateral and dorsal views.

Habitat.—The type male and allotype female, now in my collection, are from Kandy, 14-x-24. I found a few specimens of this insect near Belihul-oya, on the same stream as *P.apicalis* was found, and keeping company with *C.lankanensis* in the scrub and tree fern lining the steep banks, 13-v-32. It is closely allied to *C.digna* by its bright reddish colouring and the middorsal blue thoracic stripe; the shape of the anal appendages will serve to distinguish them at a glance.

Ceylonosticta digna (Selys)

Male. Abdomen 35-37 mm. Hindwing 23-27 mm.

Head: labium pale brown; labrum and bases of mandibles turquoise blue, the former tinted with ochreous along foreborder; rest of head bronzed black; second segment of antennae yellow; eyes azure blue with a broad equatorial belt of brick-red.

Prothorax pale blue, lower part of sides pale yellow, anterior lobe raised, posterior broadly rounded.

Thorax bright brick-red with a moderately broad azure blue mid-dorsal stripe which includes the antealar sinus, and a second similarly coloured stripe on each side traversing the middle of the mesepimeron obliquely; beneath pale yellow. Legs pale yellow, clouded or peppered with dark brown more especially at the articulations.

Wings hyaline; pterostigma dark olivaceous brown finely framed in creamy white, narrow, nearly twice as long as broad; 15 to 16 postnodal nervures in forewings, 13 to 14 in the hind; *Riv+v* arising in continuation of the nervure descending from the node, *IIRiii* distal to that nervure.

Abdomen blackish brown, this colour deepening to form broad black apical annules on segments 2 to 6 and covering the whole dorsum of segment 7 save the base; segment 8 with a blue triangular spot covering about the apical third of dorsum; segments 9 and 10 entirely azure blue on dorsum.

Anal appendages: superiors twice as long as segment 10, black, paler at apices, broad at base then constricted and again abruptly expanded in the apical half which part is strongly angulated inwards and downwards so that the apices meet in the middle line. Inferiors considerably shorter, very broad at base then a little constricted, the apical part very obtuse, expanded and with a very robust spine on the inner side directed straight inwards.

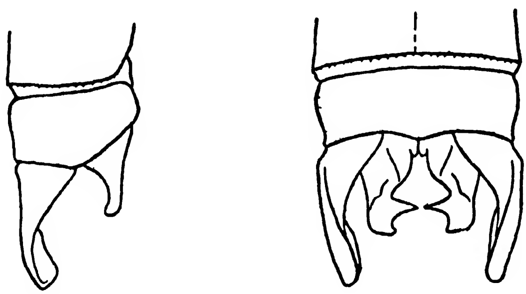


Fig. 11. *Ceylonosticta digna* (Selys).

Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 31-34 mm. Hindwing 21-24 mm.

Similar to the male but a stouter, shorter and more beautiful insect; the basal blue annules on segments 3 to 7 much broader, covering one fourth of segment 6 and fully one third of segment 7; segment 8 with only its apical joint blue, segments 9 and 10 entirely blue on dorsum

as in the male. Venation similar to the male but *Riv + v* occasionally arising a shade distad to the nervure descending from the node and *IRiii* well distad thereof.

Anal appendages short, conical, dark brown; vulvar scales brown, very robust, extending beyond end of abdomen.

Habitat.—Urugalla, Ceylon. I found a large colony of this extremely beautiful insect in rather dry scrub in the bed of the river near Urugalla. The scrub was overshadowed by larger trees but occasional shafts of sunlight filtered through and dappled the undergrowth. Specimens of *C.digna* were to be seen resting on leaves or twigs in the spots of sunlight, very conspicuous although small, by reason of their strongly contrasted bright colours against the dark surroundings. By crawling about on my hands and knees beneath the dense thorny undergrowth, I managed to secure nearly thirty specimens, males being preponderant. A small brook ran down the steep hillside and it was especially near the borders of this that most specimens were found, so that they probably breed in this, rather than in the main stream which is a mountain torrent of the first magnitude.

The male is easily distinguished from all others of the genus by the unique shape of the inferior anal appendages; the female is distinguished from others of the same group by the labrum not bordered with black as in *C.lankanensis* and *C.walli;* it is however closely similar to the female of *C.nietneri*, the more restricted blue on the dorsum of prothorax and the narrower basal abdominal annules being the only distinguishing features of the latter. Type in the Hagen collection; allotype female in my own collection. Examples will be deposited in the British Museum.

Ceylonosticta lankanensis Fraser

The original description is substantially correct but the following additions and corrections have to be made:—

Male. Abdomen 29-33 mm. Hindwing 20-24 mm.

The labrum rather broadly bordered with glossy black; eyes blue with a very broad blackish brown equatorial belt; prothorax dark bronzed brown on dorsum; thorax similarly cloured on the middorsum, and dark mahoghany red on the humeral region and sides except where traversed by the narrow azure blue oblique stripe on mesepimeron; metepimeron and beneath thorax yellow marked by a pair of small blackish spots just behind the legs below.

Wings: pterostigma nearly quadrate, no longer than broad but the costal side decidedly shorter than the posterior, covering 1 cell, usually dark reddish brown in adults; 12 to 14 postnodal nervures to forewings, 11 to 13 in the hind; *Riv + v* arising a shade before or more usually in

continuation of the oblique nervure descending from the node, *IRiii* slightly distal of that nervure, the origins of the two nervures often very close together.

Abdomen: the basal rings are pale azure blue in adults; segment 8 has a blue apical annule which may however be reduced to a small dorsal apical triangular spot.

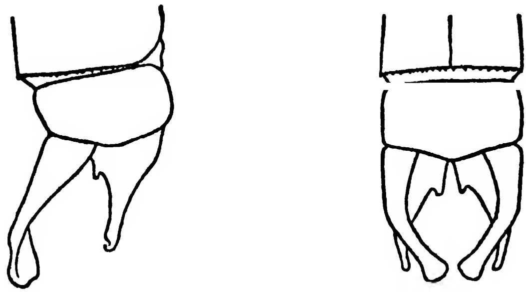


Fig. 12. *Ceylonosticta lankanensis* Fraser.
Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 30 mm. Hindwing 21 mm.

This sex has not been described, as the type, a male, was the only specimen known when the original description was made. It is similar in most respects to the male but a smaller stouter insect and with the basal abdominal blue annules much broader and correspondingly more conspicuous; segment 8 has only the apical joint blue; segments 9 and 10 entirely blue on dorsum but the former often with two small confluent triangular black spots on dorsum at base.

Wings: 13 postnodal nervures in forewings, 12 to 13 in the hind; *Riv+v* arising variably, either a shade proximal or distal to the nervure descending from the node, *IRiii* slightly or well distad of that nervure.

Habitat.—The type male comes from Kottawa, collected by Col Yerbury in April; it was this specimen which was referred to *C.montana* " with some doubt," by Kirby. I found a fairly large colony of this species in the bed of a stream some four miles above Belihul-oya during May and June; the insects were hiding up among tree ferns and scrub on the steep river bank down which a seepage flowed in which the larvae probably bred. None of these specimens was as small as the type in the British Museum but evidenced rather wide ranges in the dimensions of abdomen and wings,—Abdomen 29, 33, 35, 36 and 38 mm; wings 20, 21.5 and 22 mm. Only 2 females were found but males

were fairly numerous. Mr. Henry has taken this species at Kitulgala in April, Haldummulla in June and Pettiagalla and Balangoda in April. It is a very dark coloured insect, appearing to be quite black, marked with blue when on the wing and closely resembling a small *Indoneura*. It is closely related to *C.walli* which it much resembles, but the latter is even darker; it is to be distinguished by the uniform dark colour of the prothorax and by the shape of its posterior lobe which is broadly rounded, not produced in the midle as in *C.walli*; the blue on segment 8 is also limited to the apical border. The female is distinguished by the same characters of the prothorax and by the absence of a blue spot on the lower dorsal surface of thorax. The absence of the middorsal thoracic blue stripe will distinguish it from *C.digna* and *C.nietneri*.

Ceylonosticta walli Fraser

Male. Abdomen 35-38 mm. Hindwing 22-23 mm.

Head: labium black, extreme base whitish; labrum, bases of mandibles and anteclypeus turquoise blue, the former and the bases of mandibles broadly bordered with glossy black; rest of head black; eyes blue with a very broad dark brown equatorial belt.

Prothorax dark blackish brown except the dorsum and subdorsum of middle lobe which are azure blue or with only two small confluent middorsal blue spots; posterior lobe rounded, its middle portion produced strongly back.

Thorax dark metallic or bronzed green to beyond the humeral region, elsewhere purplish black including the whole of beneath thorax and marked on each side by a narrow oblique pale azure blue stripe which has an indentation just above its middle. Legs blackish brown, tibiae and distal ends of femora paler.

Wings hyaline; pterostigma almost quadrate but costal side a little shorter than the posterior, covering 1 cell, dark reddish brown finely framed in pale yellow; 14 to 15 postnodal nervures in forewings, 13 to 14 in the hind; *Riv+v* arising a shade proximal or in continuation of the oblique nervure descending from the node, *IRiii* distal to that nervure but the two sometimes arising very close together.

Abdomen black, segments 1 to 7 with narrow basal blue annules broadly interrupted on segment 1; segment 8 blue on dorsum to nearly as far as base, broadly so at apical border but tapering to a point near the base; segments 9 and 10 broadly azure blue on dorsum.

Anal appendages black: superiors slightly more than twice the length of segment 10, broad at base then constricted and again broadly and abruptly dilated, this portion rather sharply angulated in and down at its commencement and truncate at extreme apex. Inferiors broad

and conical at base where they present a small inner spine, then abruptly slimmed and tapered to a fine inwardly curved point; seen from above, these appendages are gently curved in towards each other.

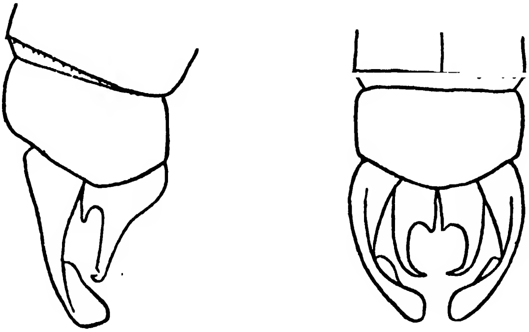


Fig. 13. *Ceylonosticta walli* Fraser.

Anal appendages of ♂, right lateral and dorsal views.

Female. Abdomen 31-32 mm. Hindwing 22 mm.

Differs in a few respects from the male, a shorter and more robust insect; mid lobe of prothorax entirely blue; a large blue triangular spot on the lower part of dorsum of thorax adjoining the coxae; side of thorax pale after the humeral region; beneath yellow with a pair of small black spots just behind the legs as seen in *C.lankanensis;* wings similar to the male but 14 postnodal nervures in all wings; *Riv+v* and *IRiii* arising very close together, the former in continuation of the nervure descending from the node.

Abdomen reddish brown; segment 2 with a narrow basal blue annule; segment 3 with a similar ring but interrupted on the dorsum; segments 4 to 7 with much broader basal annules which are notched middorsally and again laterally, that on segment 7 occupying quite the basal third of the segment; segment 8 blackish brown with its broad apical joint pale azure blue; segments 9 and 10 azure blue on dorsum, blackish brown on lower part of sides. Anal appendages very short, conical, dark brown; vulvar scales blackish brown, robust, extending beyond end of abdomen.

Habitat.—The type, a female in my own collection, was taken in Kandy in September. I discovered a small colony scattered about the steep rocky slopes of the Kadugannawa Ghat, May 4; the insects were hiding up in dense curtains of maidenhair fern which hung from the sides of numerous small brooklets meandering down the sides of the hills.

This species is quite the darkest coloured *Ceylonosticta*, even more so than *C.lankanensis* and like the latter resembles a small *Indoneura* on the wing. The female is peculiarly beautiful, its broad bright blue abdominal rings contrasting strikingly with the rich warm reddish brown ground-colour It is distinguished readily from other species of the genus by the black underside of thorax and by the shape of the posterior lobe of prothorax and the blue-marked middle lobe. The female is easily distinguished by the presence of the lower blue dorsal spot on thorax which is unique in the genus.

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CEYLON J. SCI. (B) VOL. XVII, PT. 3. (*May 19, 1933*)

A new Species of Disparoneura from Ceylon (Order Odonata)

BY

F. C. FRASER, LT.-COL., I.M.S., F.E.S.

Disparoneura leucostigma, sp. nov

Male. Abdomen 30 mm. Hindwing 24 mm.

Head entirely black save for the genae which are bright ochreous. Prothorax and thorax dull black, an obscure lateral ochreous spot on the former and two ochreous lateral oblique stripes on the latter, one traversing the centre of mesepimeron, the other running along the lower border of metepimeron; beneath thorax black with a median longitudinal yellow stripe overlaid by chalky white pruinescence. Legs black.

Wings hyaline but tinted evenly throughout with dark brown; pterostigma diamond-shaped, strongly braced, very oblique, pale creamy opaque white framed in thick black borders; 18 to 19 postnodal nervures in forewings, 17 in the hind; petiolation extending nearly to the level of the proximal antenodal nervure, especially in the hindwings; *Ac* situated much nearer the distal antenodal.

Abdomen black, segment 1 pruinosed white on dorsum. Anal appendages black; superiors as long as segment 10, almost quadrate as seen in profile but with the lower apical angle produced into a robust spine and the upper distal angle curled somewhat outwards as if the appendage had buckled; inner borders apposed as seen from above, the outer very sinuous; inferiors rather longer, very broad at base, tapering rapidly and sloped downwards, the apex minutely clubbed and curled slightly inwards. Penis with a fine dorsal spine and the apex strongly bifid, split into two curling branches which are saddled over the stem of the organ.

Female. Abdomen 29 mm. Hindwing 24 mm.

Differs in several respects from the male; a more robust and stockier insect; wings only palely enfumed but the pterostigma similar to the male's; 18 postnodal nervures to forewings, 16 in the hind; petiolation ceasing at level of proximal antenodal. The markings better defined and more extensive—bases of mandibles, genae and a narrow stripe crossing the face, confluent with former, bright ochreous; a narrow reddish stripe traversing the vertex at level of the anterior ocellus; eyes ochreous above and below, these areas confluent with the ochreous

areas of face and vertex and divided by a thick equatorial black line; thorax with broader, brighter and better defined oblique lateral stripes and in addition a narrow brick-red antehumeral stripe on each side of dorsum; prothorax with a large bright ochreous spot on each side. Abdomen black, the ventral borders narrowly ochreous, especially on segment 8. Anal appendages shortly conical, black; vulvar scales black, very robust, extending to end of abdomen.

Habitat.—Nuwara Eliya, 6200 feet, Ceylon; several specimens taken by Mr. Henry on the borders of a small stream in deep jungle on 7-v-27. The species is distinct from all others of the genus by its pale white pterostigma and deeply enfumed wings. The juvenile male probably has a stripe on the vertex and narrow antehumeral stripes like the female. Type and allotype female in the Colombo Museum.[1] The penis is closely similar to the organ found in genus *Hypolestes* and suggests a close relationship which may be more apparent than real.

[1] The type, in accordance with the usual practice of the Colombo Museum, will be presented to the British Museum (Natural History) on publication of this paper.

CEYLON J. SCI. (B) VOL. XVII, PT. 3. (*May 19, 1933*)

A new Mountain-stream Fish

BY

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(With One Text Figure.)

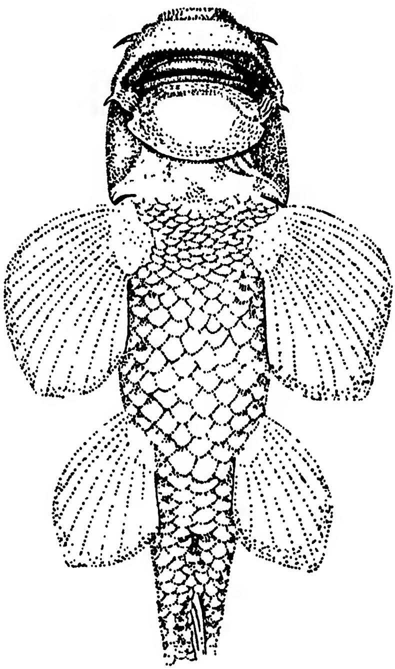
The genus *Garra* was latterly considered by Day (1889) to consist of three species which included forms he once regarded as separate. Hora (1921) brought the genus up to date with 21 Indian species and noted that scales and fin rays were not very helpful as specific characters. In 1930 I examined specimens from various localities ranging from Nuvara Eliya (C.P.) 6000 feet to Kumana (E.P.) at sea level and concluded that there was only a single Ceylon species, with variable rostral nuptial excrescences. It was also noticed that in Ceylon, *Garra* shows a decided tendency to desert the mountains for the low country where it attains to a larger size and fuller body.

In 1931 a collection of 76 *Garra* was obtained from Gammaduva (C.P.), altitude 3400 feet, in which were numerous specimens markedly different from those collected elsewhere. They however showed a gradual approximation to the ordinary form, hence although the two extremes were very different in appearance it was considered that the fish should only rank as a subspecies.

Four Gammaduva specimens and four from Ratnapura (Sab. P.) were sent to Dr. S. L. Hora of the Indian Museum for his valuable opinion which is here quoted. ' The two forms represented in your lot appear to be quite distinct and one is undoubtedly *Garra ceylonensis*. The other with the broad mouth and straight lower jaw corresponds with *G. gotyla* (Gray) of the Himalayas.' He further states that " The Ceylonese *G. gotyla*, if I may use this phrase, seems to have evolved the characters of the species independently, so that these two forms are the result of a parallel evolution ". He also considers the fish entitled to rank as a new species or subspecies.

From time to time writers have commented on the isolation of the Gammaduva area with its steep mountains. *Garra* collected from Kandy, Hantana Peak, Teldeniya, and Peradeniya, which are close by, are typical *ceylonensis* as are those from much higher altitudes such as Nuwara Eliya, Bandāravela and Diyatalāva. Hence enhanced speed of water resultant on steep gradient appears to have

produced this new subspecies. It is probable that the Himalayas produced *Garra gotyla* in like manner. It has also been noticed that young specimens of *G. ceylonensis ceylonensis* often show a closer resemblance to the new subspecies than do the adults. This suggests that the new form may have been the parent stock which once populated all the hills from the Himalayas southward and has subsequently modified its shape to form new species.



Garra ceylonensis phillipsi, subsp. nov.
Ventral view $\times$ 1.6

Garra ceylonensis phillipsi, subsp. nov.

The characters of *Garra ceylonensis phillipsi* which I name after Mr. W. W. A. Phillips of Gammaduva, who obtained the specimens for me, are as follows:—

It has a triangular outline, wide mouth, absence of ventral median groove in rostral fold, straight lower jaw, wide depressed head, comparatively large scaleless area on chest, the chest and belly flat and the long pectoral when adpressed has its tip only 0.5-1.5 scales

remote from insertion of ventral instead of 3-4 scales. The distance from end of head to origin of dorsal is contained 1.5 in lateral length of head, in *ceylonensis* it is as long or longer than head length.

There is no marked specific difference in the number of scales and fin rays but *phillipsi* is darker and of smaller size 55-75 mm. against the 115-123 mm. of *ceylonensis*.

The new form differs from a 130 mm. *Garra gotyla* kindly sent me by Dr. Hora in that *gotyla* has a deep transverse rostral sulcus dorsally, the tip of the pectoral is 4 scales remote from insertion of ventral, the cloaca is midway between insertion of ventral and anal whereas in the two Ceylon subspecies it is twice as close to anal as to insertion of ventral. In *gotyla* the distance from end of head to origin of dorsal is rather more than its lateral head length. These features help to distinguish the new subspecies from its nearest Indian relative. The type specimen which is 70 mm. long with LL.35, predorsals 10, is deposited in the British Museum, three paratypes are in the Indian Museum, Calcutta.

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CEYLON J. SCI. (B) VOL. XVII, PT. 3. (*May 19, 1933*)

The Apoda of Ceylon

BY

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(With One Plate.)

Apoda are the most primitive living Amphibia and comprise 19 genera belonging to a single family. Reproduction is by large yolked eggs, except in the aquatic *Typhlonectes* which is ovoviviparous. The embryonic stages present several interesting features such as the temporary formation of an elasmobranch-like spiracle from the first visceral cleft, and, in *Hypogeophis*, the presence of 9 visceral arches homologous to those of primitive fishes. Adults of the more primitive genera are the only Amphibia to possess scales, probably derived from embolomerous ancestors of the Carboniferous.

Apoda occur in tropical Asia, America and Africa but are absent from Madagascar. *Ichthyophis* is the only Ceylon genus but India has in addition *Uracotyphlus* and *Gegeneophis*, which last is scaleless.

The Order Apoda has the following characters:—

Body apodal, elongate with numerous annular grooves. Eyes subcutaneous; skull compact, its roof more or less entire. Tail short. Copulatory organ protractile. Oviparous or ovoviviparous.

Skin smooth, slimy. Annular grooves with or without scales. Snout with a protractile lateral tentacle. Two spiracula, temporary or permanent. Habitat: In tropical Asia, Africa, America. A single family, the Caeciliidae.

Genus **Ichthyophis** Fitzinger

Annular grooves with subdermal scales. Tentacle conical, close to lip and between naris and eye. Teeth on jaws in one or two rows. A postfrontal bone present. Embryo[1] with three pairs of external gills. Larva with two spiracula and a fin fold on the tail. Oviparous. Distributed from India to western part of Indo-Australian Archipelago.

[1] The Sarasins (1887-1890) published an almost complete account of the development of *I. glutinosus*. Their collections and observations were made in Ceylon.

KEY TO CEYLON SPECIES.

1. Colour uniform; in adult, snout length less than interorbit.—*I.monochrous*
2. A yellow lateral band; in adult, snout length equals or exceeds interorbit. —*I.glutinosus.*

Ichthyophis monochrous (Bleeker)

Epicrium monochrous Bleeker, 1859. Nat. Tijdschr. Ned. Indie XVI.

Snout bluntly conical, its length contained about 1.5 in interorbital space. Eye nearly above middle of gape. Tentacle rather closer to eye than to naris. Teeth in two series on each jaw, the inner row on lower jaw does not extend as far back as the outer. Head and throat smooth. Two transverse grooves across throat, one behind angle of jaws, the other midway between this and the first annulus and is formed by the opercular fold. Body depressed. Annuli faintly 'V' shaped at dorsal mid-line but straight-edged ventrally—total number 235-360. Cloaca an elongate slit interrupting 5 annuli; tail short, conical, feebly compressed terminally, consisting of 6 annuli.

Colours: Purplish brown, lighter beneath with a yellowish tinge Tentacles white.

Dimensions: (Gravely's specimen in spirits).

Total length 278 mm.; tip of snout to first annulus 15 mm.; snout 4.5 mm.; eye 1 mm.; interorbit 6 mm.; gape 6.5 mm.; width of body 12 mm.; depth 8 mm.; cloaca 1.5 mm.; tail 2 mm.

According to van Kampen (1923) this species attains to 500 mm. in length.

Distribution: Three workers appear to have noticed this species in Ceylon. Kelaart (1852) mentions a mutilated *Ichthyophis* from Kandy. The specimen was " of a brown colour above, and a pale yellow brown beneath, without the side streak of *Ichthyophis glutinosus* ". He also states that Dr. Templeton " found a new species in the Island." Dr. F. H. Gravely of the Indian Museum obtained a specimen at Pattipola (C. P.) on August 2, 1915. This is the only specimen in the Colombo Museum and has 298 annuli.

Kandy, Pattipola (C. P.)

Ceylon, India to Malay Peninsula, Singapore, Sumatra, Java, Borneo, Phillippines.

Ichthyophis glutinosus (Linné)

Plate XXXVII.

Caecilia glutinosa Linné, 1758. *Syst. Nat.* ed. 10.
Ichthyophis glutinosus Sarasin, 1890. Erg. Naturw. Forschungen auf Ceylon II.

Munn Unni (Tamil) = Sand tick

Snout bluntly conical, rather prominent. In the adult its length equals or exceeds interorbital space; but is less in adolescents. Eye nearly above middle of gape. Tentacle about twice as far from naris as

from eye. Teeth in two well developed series on both jaws. The inner row on lower jaw reaches nearly as far back as the outer. Head and throat smooth. Two transverse grooves across throat; one behind angle of jaws, the other midway between this and first annulus and formed by the opercular fold. Body subcylindrical, feebly depressed. Annuli ' V ' shaped at the mid-dorsal and mid-ventral lines. Dorsally they point anteriorly and are less acute than ventrally where they point posteriorly. The annuli frequently bifurcate especially posteriorly. Near the cloaca they are straight. Total number of annuli 240-400. Cloaca an elongate slit interrupting 5 annuli. Tail short, conical, feebly compressed terminally and consisting of 6 annuli.

Colours: Dorsally dark purplish brown; ventrally somewhat lighter. A distinct lateral band of yellow ochre from snout to tail in larva, from head to tail in adult. Aquatic larva pale yellow ventrally.

Reproduction. The male has a distensile copulatory organ. According to the Sarasins (1890) the breeding season is during the south-west monsoon, *i.e.*, March till September. The animal lays ten eggs in her burrow close to water and coils herself around them. Each egg is about 9 by 6 mm. and connected with the others by its tendril-like chalazae. As development progresses the eggs become spherical and nearly twice their original size. The embryo has three pairs of long external gills. These disappear in the eel-like larva which, on hatching, takes to water. It has a pair of spiracles within each of which may be seen three plate-like vestiges of the branchial arches. Two such aquatic larvae 94 and 96 mm. long were found by me in a collection of fishes from the paddy fields of Gilimalé (Sab. P.) 1929. Plate XXXVII, figs. 1, 2.

In these the head is depressed with a square snout having labial folds distinct from snout tip. Jaws dentigerous. Eyes comparatively large and dorsal. There are numerous lateral line sense pits which gradually disappear, those on the head being most persistent. Tentacles absent. No smooth collar behind head, but the throat groove formed by the opercular fold lies slightly in front of spiracles. Body relatively more depressed than in adult; annuli barely discernible. Tail strongly compressed, as deep as body, with a distinct dermal fin fold which gives it a spatulate lateral outline. Plate XXXVII, fig. 3.

Dorsal colour purplish brown, with a yellow lateral band interrupted at spiracle; ventrally very pale yellowish brown.

Metamorphosis appears to be completed on land and the animal forsakes the water before the vestigial branchial arches have disappeared. Two such terrestrial larvae were discovered in an old collection from Peradeniya (C. P.). The other five individuals were adults, hence probably all were obtained together. The presence of dark ventral pigment in the two larvae further supports the view that they were

terrestrial. These specimens were 125 and 157 mm. long respectively. The upper labial fold had fused with the snout anteriorly and was not distinct as in Plate XXXVII, fig. 2. The upper lip enfolded the posterior half of the lower by curling into the post-labial groove of the latter. The eyes were lateral and the sense pits had disappeared almost entirely. The tentacle appeared in a pit on the lower anterior border of the eye. The spiracular openings were about as large proportionately as in the aquatic larva but only two vestigial branchial arches were discernible instead of three as in the previous stage. The posterior boundary of the collar had developed and between this and the head were 10-12 annuli which disappear in the adult to form a smooth collar. The spiracle was considerably closer to the anterior throat groove of the opercular fold than to the posterior edge of collar. The caudal fin fold was much reduced and the tail more conical. The yellow lateral bands were very distinct and widest on head but interrupted at spiracle. The ventral pigment was brown as in the adult.

The stages of postembryonic development in *Ichthyophis glutinosus* may be summarized as follows:—

(A) *Larva* with two spiracles and caudal fin fold. Snout length does not exceed interorbital width. (1) Aquatic, (2) Terrestrial.

(1) Aquatic. Body depressed, snout square, no tentacle, sense pits present on head and lateral line. Each spiracle with 3 vestigial branchial arches. Annuli indistinct. A yellow lateral band from snout tip to tail tip; ventral pigment pale yellow.

(2) Terrestrial. Length 125 mm. Snout square, tentacle in orbit; upper lip partially enfolds lower; sense pits nearly absent. Each spiracle with two vestigial branchial arches. Boundaries of collar and its annuli defined; ventral pigment brown.

(B) *Adolescent.* Over 170 mm. long. Snout subconical its length not exceeding the width of interorbit. Tentacle on upper lip; sense pits, spiracles and caudal fin fold absent. No annular grooves on collar. Yellow lateral band from snout tip to tail tip.

(C) *Adult.* Over 250 mm. long. Body subcylindrical, snout longer than interorbital width. Yellow lateral band well defined, greatly reduced or absent from head.

Dimensions: (Aquatic larva in spirits). Total length 96 mm., tip of snout to spiracle 9 mm. Snout length 2 mm., eye 0.9 mm., interorbit 2.7 mm., gape 4 mm. Width of body 4 mm., depth 3 mm., length of cloaca 2 mm., tail 5 mm.

(Terrestrial larva in spirits.) Total length 157 mm., tip of snout to spiracle 9.5 mm., snout length 2 mm., eye 0.9 mm., interorbit 3 mm., gape 4 mm., width of body 8 mm., depth 5 mm., length of cloaca 2 mm., tail 2.5 mm.

(Living adult.) Total length 330 mm., tip of snout to first annulus 26 mm., head length 17 mm., snout length 12 mm., eye 0.9 mm., interorbit 7.5 mm., gape 11 mm., width of body 14 mm., depth 11 mm., length of cloaca 3 mm., tail 4 mm.

Food: Earthworms and small burrowing snakes. Nematode parasites occur in the intestines of some individuals.

Distribution: A fossorial form which inhabits swampy ground, close to streams in hilly and mountainous country. Occasionally found under boulders and in the damp silt of field drains. It comes to the surface at night, especially during rain, and swims actively with an eel-like movement. Its movements on land are similar, but, when burrowing, the body annuli grip the ground by distension, as in an earthworm.

Perādeniya, Kandy, Gammaduva, Gōnagama, Lindula, Kitulgala (C. P.), Balangoda, Ratnapura, Gilimalé (Sab. P.), Hanvella, Matugama (W. P.).

Ceylon, South India, Eastern Himalayas to Malay Peninsula, East Indies.

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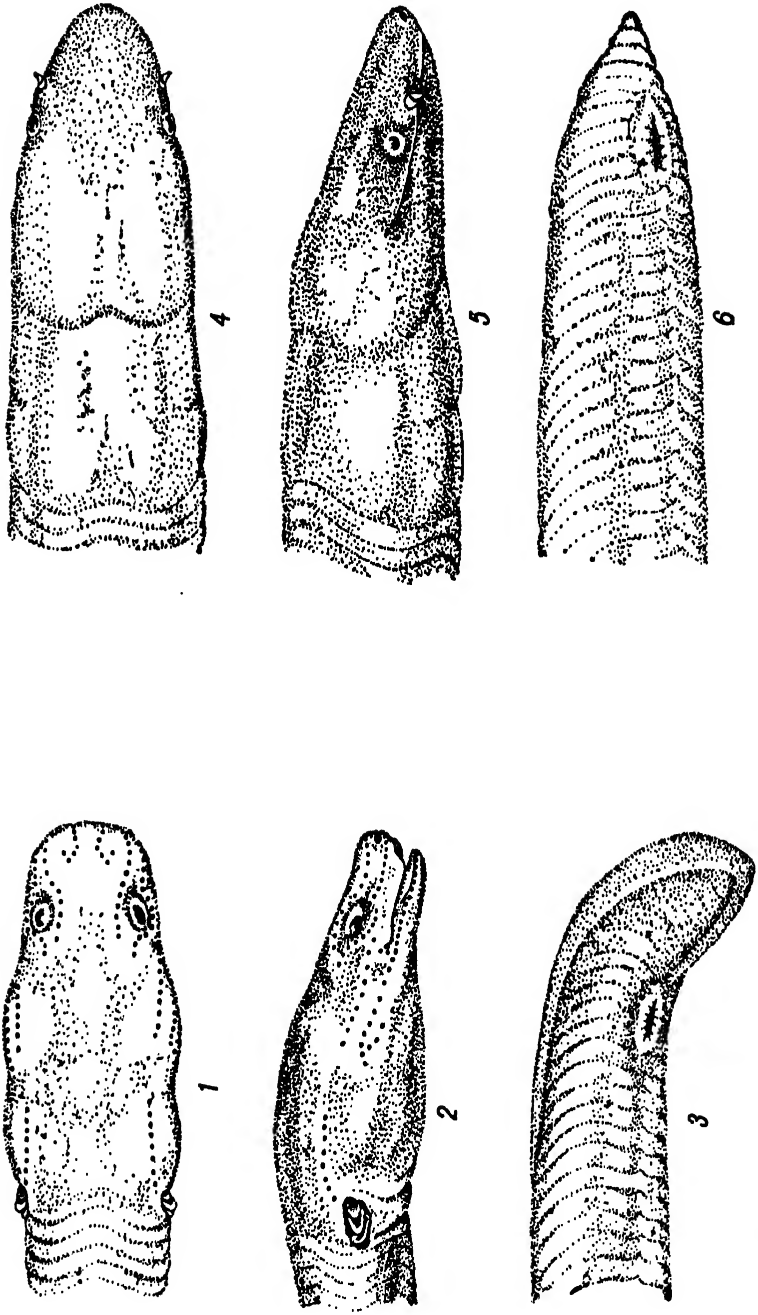
EXPLANATION OF PLATE

Plate XXXVII, *Ichthyophis glutinosus* (*Linné*)

Fig. 1. Dorsal view of head of aquatic larva ... ... × 5.3
Fig. 2. Lateral view of head of aquatic larva ... ... × 5.3
Fig. 3. Left lateral view of tail of aquatic larva ... ... × 5.0
Fig. 4. Dorsal view of head of adult ... ... × 2.5
Fig. 5. Lateral view of head of adult ... ... × 2.5
Fig. 6. Left lateral view of tail of adult ... ... × 2.5



Ichthyophis glutinosus (Linné)

P. Deraniyagala del.

CEYLON J. SCI. (B) VOL. XVII, PT. 3. (*May 19, 1933*)

Survey of the Distribution of Mammals in Ceylon

BY

W. W. A. PHILLIPS, F.Z.S., M.B.O.U.

REPORT No. 8

Collection	...	No. 9.
Locality ...	...	Hiyara, near Galle, Southern Province.
Altitude ...	...	Approx. 380 ft.
Date ...	...	May 17 to 24, 1932.
Collector ...	...	Mr. E. C. Fernando, Taxidermist, Colombo Museum.

In May this year, Mr. E. C. Fernando collected a few specimens on a collecting trip to the reserved area adjoining the Galle Waterworks reservoir, in the extreme south-west of the Island. Unfortunately, the south-west monsoon set in earlier than usual and spoilt his trip, forcing him to abandon it after one or two days of heavy rain.

Being situated in the south-westerly low-country wet zone, this area, most likely, contains a number of interesting forms peculiar to the Island and it is to be hoped that Mr. Fernando will be able to make another visit, in better weather, in order to make a really representative collection.

The country in the immediate vicinity is composed of low hills, densely covered with fairly high forest and occasional clumps of dwarf bamboo. Much of the surrounding country has been opened up into rubber, tea and cinnamon estates. The rainfall averages 115 inches in the year; the rain being fairly evenly distributed, but heaviest while the south-west monsoon prevails.

The most interesting specimen in this collection is the single male *Funambulus layardi signatus*, a little known striped squirrel which as far as our knowledge goes, is peculiar to the south-west wet zone.

(No. 12) [1] Rhinolophus beddomei sobrinus

The Great Horse-shoe Bat

♂ 1.

A solitary male, flushed from the side of a mound in the jungle, and shot. Rather darker than usual.

(*See also Reports Nos. 3 and 6*)

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1 The numbers in these Reports are those given in " A check-list of the Mammals of Ceylon " by W. W. A. Phillips, Ceylon J. Sci., Sect. B. XV, 1929, p. 119.

(No. 28) **Taphozous longimanus** Hardwicke

The Long-armed Sheath-tailed Bat

♂ 1. A young adult male, with dark reddish brown fur.

'Driven out of a crown of a coconut palm, and shot.' In Ceylon, this species generally appears to choose the crown of a coconut palm, in which to pass the day. The species is uncommon.

(No. 30) **Saccolaimus saccolaimus** (Temminck)

The Pouch-bearing Sheath-tailed Bat

♀ 1. Typical.

'Shot flying over at dusk.' A very common bat in the south-westerly wet zone.

(No. 71) **Funambulus layardi signatus** Thomas

The Flame-striped Jungle Squirrel

♂ 1.

'Shot in heavy jungle near the reservoir; the only specimen seen.' This locality shows a considerable extension to the range of this interesting little squirrel. Hitherto, it had been known only from the Balangoda, Ratnapura and Rakwana districts.

(No. 76) **Rattus rattus kandianus** Kelaart

The Common Ceylon House Rat

♂ 1, ♀♀ 2. All typical.

'Trapped in the jungle.' The male is an exceptionally large specimen; the measurements are:—Length head and body, 197 mm.; tail 216 mm.; hindfoot 32 mm.; ear 20 mm.

(*See also Report No. 2*)

(No. 86) **Golunda ellioti coffaea** Kelaart

The Coffee Rat

♂ 1.

'Shot in bamboo jungle.' Rather a dark specimen. Probably the low-country wet zone form of this bush rat will prove to be sub-specifically distinct from the dry zone form.

(*See also Report No. 2*)

REPORT No. 9

Collection	...	No. 10.
Locality ...	...	Bibile district, Uva Province.
Altitude ...	...	400 ft. to 1,100 ft.
Date ...	...	September 19/23, 1932.
Collector ...	...	Mr. E. C. Fernando, Taxidermist, Colombo Museum.

Another small collection was made on a short trip, taken by Professor W. C. Osman Hill accompanied by Mr. E. C. Fernando, into the Bibile district jungles of the Uva Province. The primary object of this trip was to discover traces of, and to collect material and data concerning, the Veddahs, the aboriginal race that used to inhabit the low-lying jungles of the Uva and Eastern Provinces.

The collecting of small mammals was a secondary consideration and could be carried on only occasionally, as the party was continually on the move. Little trapping was done, owing to the lack of opportunity; bats were practically the only mammals that were obtained.

A collection of small rodents from this district would, most probably, prove to be of great interest.

The country in which this collection was made lies in the intermediate zone between the comparatively wet mountain zone and the low-country dry zone. It is essentially hilly, as it is here that the eastern aspect of the Uva hills descends gradually to the level of the low-country proper.

The heavy jungle is generally confined to the ravines and valleys, the hills being covered, chiefly, with high 'mana' grass, scrub and patna. Much of the grass is burnt off by the local villagers, annually, during the dry season. This practice contributes to the scarcity of wild life. The rainfall averages approximately 80.75 inches annually, most of which falls during the north-east monsoon period—October to January.

(No. 13) **Hipposideros lankadiva** Kelaart

The large Indian leaf-nosed Bat

♂ 1. In alcohol. Udadambiya (400 ft.).

This large bat—the largest of the insectivorous forms found in Ceylon—has evidently a much larger range that has been supposed. It would appear, however, to be very locally distributed.

(See also Reports Nos. 2 and 3)

(No. 20) **Pipistrellus coromandra** (Gray)

The Coromandel Pipistrelle

♀ 1. In alcohol. Udadambiya (400 ft.).

A large female, of the typical bistre colour. Udadambiya being on the boundary of the dry zone one would expect to find this species quite common in this neighbourhood.

(See also Reports Nos. 2 and 6)

(No. 22) **Hesperoptenus tickelli** (Blyth)

Tickell's Bat

♀ 1. In alcohol. Medagama (800 ft.).

This species appears in nearly every collection made in the low-country, whether in the dry zone or the wet. It seems to be a very common species throughout the Island, with the exception of the hills over 4000 feet. Its habit of flying moderately high up, early in the evenings, brings it into prominence and makes it easy of collection.

(*See also Reports Nos. 2, 3, 5 and 6*)

(No. 23) **Scotophilus kuhli** Leach

The Common Yellow Bat

♀♀ 2. In alcohol. Medagama (800 ft.).

Both these specimens are of the usual dark brown colour, with the typical yellowish suffusion. They are interesting as one contained one foetus and the other two. Previously, one of these bats had been found with a single foetus in October. It would appear probable, therefore, that the general season for the production of the young is during the intermonsoon period—September to October.

(No. 24) **Scotophilus wroughtoni** Thomas

Wroughton's Bat

♂♂ 3. Medagama (800 ft.).

Three specimens of this bat, which has hitherto been considered rare in Ceylon, were shot. Mr. Fernando reports that the species appears to be common around Medagama. It is very probable that, in reality, the species is by no means uncommon throughout the whole of the low-country dry zone but it is, apparently, locally distributed.

The three males procured were all of the same uniform biscuit brown on the upper parts, with the lower parts considerably lighter, but not white as in typical specimens.

(*See also Report No. 2*)

(No. 28) **Taphozous longimanus** Hardwicke

The Long-armed Sheath-tailed Bat

♀ 1. Medagama (800 ft.).

This specimen was shot while flying over, high up, and Mr. Fernando reports that he saw a number of others. I am inclined to think that this species may be fairly common over a great part of the Eastern low-country though it has been collected but rarely.

The present specimen is a youngish female, with a dark grey pelage; it was in an advanced stage of pregnancy and contained one large foetus

(*See also Report No. 8*)

(No. 61) **Petaurista philippensis lanka** Wroughton

The Large Grey Flying Squirrel

♀♀ 2. **Danigala (800 ft.).**

Both these specimens are quite typical. Both were shot at night with the aid of an electric torch. One appears to have given birth to a young one, quite recently, for the mammae were functioning.

This locality is probably very near to the extreme limit of the easterly range of this animal; I do not think that it ever occurs in the low-country dry zone, proper.

(No. 73) **Tatera ceylonica** Wroughton

The Ceylon Gerbil

♂ 1, ♀ 1. **Ududambiya (400 ft.) ; Bulupitiya.**

Two good specimens of this very common animal; both quite typical.

(*See also Reports Nos. 3 and 4*)

(No. 76) **Rattus rattus kandianus** Kelaart

The Common Ceylon House Rat

♂ 1. **Danigala (1100 ft.).**

A very large male, with a rufous coat and white underparts. Among the fur of the back are a number of unusually long piles. This species is liable to so many variations in colour, size and coat that it is almost impossible to differentiate the races. The present specimen is not typical of *kandianus;* it appears to approach more closely to the mainland form *rufescens.*

(*See also Reports Nos. 2, 3 and 4*)

The following animals were also seen, or their presence was noted, by either Professor Hill or Mr. Fernando.

(No. 2) **Pithecus entellus thersites** Kelaart

The Ceylon Langur

" One troop seen."

(No. 42) **Panthera pardus fusca** (Meyer)

The Indian Panther or Leopard

" Foot marks plentiful, but no animal seen."

Ratufa macroura sub sp. ?

The Ceylon Giant Squirrel

' Observed high up in the trees.' This would probably be the submontane form *dandolena,* but it might be the low-country race, *sinhala-*

(No. 88) **Lepus nigricollis singhala** Wroughton

The Ceylon Black-naped Hare

" Shot and eaten."

(No. 89) **Bubalus bubalis bubalis** (Linné)

The Wild Buffalo

" One good herd of about 50 individuals, in a valley at the foot of Danigala rock."

(No. 91) **Axis axis ceylonensis** Fitzinger

The Ceylon Spotted Deer

" Plentiful."

(No. 93) **Rusa unicolor unicolor** (Kerr)

The Sambhur

" Plentiful."

(No. 95) **Sus cristatus cristatus** Wagner

The Indian Wild Pig

" Plentiful."

(No. 96) **Elephas maximus zeylanicus** Blainville

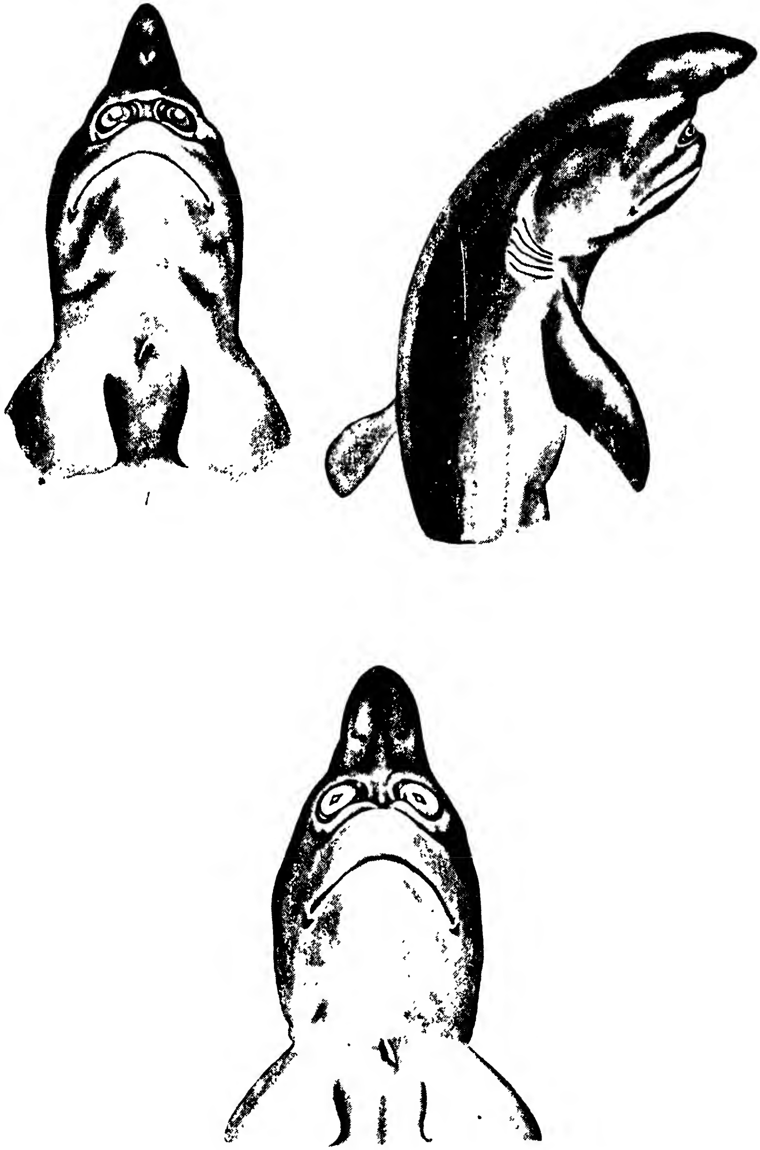
The Ceylon Elephant

" Plentiful."

(No. 97) **Manis crassicaudata** Geoffr. St. Hilaire

The Indian Pangolin

" None seen, but plenty of evidence of their existence."



P. Deraniyagala del.

Shark monstrosities

Fig. 1. Ventral view of specimen 1 $\times 1\frac{1}{3}$

Fig. 2. Right lateral view of specimen 1 $\times 1\frac{1}{2}$

Fig. 3. Ventral view of specimen 2 $\times \frac{3}{5}$

NOTES

1. Two Shark Monstrosities

Plate XXXVIII

When Stockard [1] treated developing eggs of *Fundulus* with magnesium chloride some of the resulting larvae were cyclopean while others had both eyes fused and subventral. It is now found that sharks produce somewhat similar abnormalities under natural conditions and two such are here described.

(1) The first (Plate XXXVIII, figs. 1, 2) was purchased at the Colombo market in 1925. As a spirit specimen it was dark dorsally, light ventrally. The head was flexed ventrally while the snout, which curved downwards, was conical and gave the head a likeness to the Mitsukurinidae or goblin sharks. There was a single nasal opening set in a protuberance on its ventral side.[2] The eyes were confluent and bounded ventrally by well developed lids which were also confluent and formed two small protuberances, one at the external angle of each eye. Completely surrounding the eyes was a deep groove. The jaws were level and the upper projected to cover the lower half of the eyes although in the illustration, the jaw is pulled down to expose the eyes. A postlabial groove lay at each angle of gape. When the mouth was closed the mandibular teeth lay against the skin of the upper jaw which was so wide that its teeth lay over the tongue.

The umbilicus was in line with the origins of the pectorals and denoted that the specimen was newly born. The first dorsal fin was spatulate, the second dorsal, normal. The pectorals extended beyond the level of the first dorsal. The caudal peduncle had a notch dorsally near the base of the caudal fin.

Dissection showed that the fused eyes were on a single stalk and that the brain occupied the rostral protuberance and did not extend posterior to the angle of gape.

(2) The second specimen was smaller than the previous one. It was taken from a *Eulamia melanoptera* (Quoy et Gaimard) about 3 metres long which was captured at Weligama (S. P.) and opened at Colombo on June 21, 1932. Out of a brood of 24 embryos this was the only abnormal specimen and in addition to its peculiar head, it possessed short fins and was an albino.

1 1903. *Journal of Experimental Zoology.*

2 Marsipobranchs, the most primitive fish-like vertebrates have only a single naris.

14——J. N. 27233-429 (1/33)

Plate XXXVIII, fig. 3 is a ventral view with the upper jaw pulled down to show the eyelids. In side view the snout resembled that of the previous specimen but was flattened ventrally with two nares set wide apart and separated by a rostral ridge.

The eyes were elongated antero-posteriorly, contiguous and possessed confluent lids. The circumorbital groove was interrupted mesially at the anterior edge and at this point a small patch of scales invaded the angle of each eye.

The prominent upper jaw concealed the lower half of each eye. A postlabial groove existed at the angle of gape. The jaw formation was similar to the previous specimen. Two endolymphatic openings were present on top of the head above the angle of gape. The body shape was normal although the fins were short.

The colours of a normal embryo were: slaty blue dorsally, white ventrally; black tips to pectorals, ventrals, anal and second dorsal. A black margin on the upper edge of the caudal fin which also had dark tips. The tip of first dorsal was dark while the notch on the caudal peduncle was in a black spot.

The dimensions of the abnormal and normal specimens were as follows:—

	(1) mm.	(2) mm.	Normal. mm.
Snout tip to caudal fin tip	550	525	570
Snout tip to base of caudal fin	350	375	390
Snout tip to 1st gill	109	103	105
Snout tip to last gill	134	125	131
Snout tip to origin of I. D	196	176	181
I. D to II. D	156	122	112
Height of D	38	33	95
Length of P	93	75	135
Length of snout	30	34	45
Length of lower jaw	30	22	31
Width of lower jaw	48	43	50
Distance between endolymphatic pores	10	10	11

P. E. P. DERANIYAGALA.

2. The Cry of the Ceylon Scops Owl (*Otus sunia leggei*)

I.

'*Wook, took-toorroo - - - wook, took-toorroo - - - wook, took-toorroo*'. At twlight one evening, early in January this year (1932), this now familiar, haunting cry resounded again through the growing darkness surrounding my bungalow. Last year I had heard it by night, on two or three occasions during the north-east monsoon period, both

at Mousakande and at Opalgalla close by. But always it had been on the move, here one minute further away the next and then again in the far distance. And although I had gone out with a torch on several evenings either mist or distance had prevented me from obtaining a glimpse of the bird from which the cry originated.

This year, however, the cry was nearer and stationary and there appeared to be a more hopeful chance of discovering its origin. '*Wook, took-toorroo - - - wook, took-toorroo - - - wook, took-toorroo*' night after night the cry continued monotonously, now faint, now loud but always weird, haunting and elusive.

Wait[1] tells us that the origin of the cry has always been in doubt. Legge thought it was, possibly, the call of *Ninox scutulata*, the Brown Hawk-Owl. Wait, himself, favoured the belief that *Batrachostomus moniliger*, the Ceylonese Frogmouth, was the author; but A. L. Butler attributed the cry to our little friend the Ceylon Scops Owl, *Otus sunia leggei*, and he has proved to be right.

'*Wook, took-toorroo - - - wook, took-toorroo*', each night at dusk the cry was wafted on the still night air, issuing forth either from a small jungle beside a clearing or from a tall banyan tree standing almost alone below the bungalow cart road. On some nights the cry would commence a little earlier than on others but, as dusk deepened into night one always found oneself listening, subconsciously, for it to begin—and sooner or later, without fail, begin it would. Sometimes, after ten minutes or so, there would be a lull, but usually the monotonous call would be kept up for three-quarters of an hour or more without cessation; then after a rest of half an hour or so it would start again, to be kept up, intermittently throughout the night.

Awake at any odd hour, either before or after midnight, one would hear it, especially on moonlight nights, a steady incessant and most monotonous cry, with an unvarying cadence and a beat of just three seconds between the calls. '*Wook, took-toorroo - - - wook, took-toorroo - - - wook, took-toorroo*'.

To elucidate the origin of the cry became more and more a matter of interest. Though it was suspected, from the open position of the banyan tree and the stationary nature of the cry, that it was made by an owl, yet certainty was demanded. After darkness had set in, there was little or no hope of distinguishing the bird but in the early dusk or with the aid of a bright moon, there seemed every chance of our being able to make a certain identification.

Evening after evening, therefore, just as dusk was beginning to fall, two of us would sally out with a torch and guns, to take up positions commanding the favourite banyan tree. On several nights we were too late, the bird was already there before us and nothing we could do

[1] Wait, *Birds of Ceylon* 2nd Edition, 1931, p. 238.

would interrupt it or make it show itself. Of the electric torch, flashed in his direction, he took no notice and stones or gravel he ignored. At last, however, after more than a week of failure, a glimpse of him was obtained as he flew up to a topmost branch to commence his nightly serenade. The glimpse was sufficient to show that he was a very small owl but even so we had yet to prove his species—and to shoot him had not been possible.

After this he moved down, more or less permanently, to the small jungle below the clearing, to continue his nightly calling with unabated vigour.

It was just at this time that Mr. G. M. Henry, the author of the beautiful *Coloured Plates of the Birds of Ceylon* came to spend a few days with me, and it fell to him to confirm the identification. Descending into the jungle, Mr. Henry met him on two occasions, almost face to face, and fixed his identity with complete certainty as the Little Scops Owl, *Otus sunia leggei*.

Whether his incessant calling was in the way of a serenade to his mate, or whether it was a call for a mate, I was not able to ascertain. On one or two occasions, soon after he first commenced to call, one of us thought that his cry was answered and that, at times, two birds were engaged in answering one another but we were never quite certain on this point. He did, however, continue in residence from the early part of January until the middle of May, when the south-west monsoon winds made his jungle untenable. The likelihood is that he had his nest somewhere near his favourite haunt.

Now the south-west winds are with us again, we listen in vain, tinged perhaps with regret, for the familar '*Wook, took-toorroo - - - wook, took-tooroo - - - wook, took-toorroo*' of our little fair-weather visitor.

W. W. A. PHILLIPS.

II.

The cry sounded to me more like the syllables "*tuk, tok-torok - - - tuk, tok-torok - - -*", the first syllable being much fainter than the other two and not audible at any great distance. A. L. Butler (*J. Bombay Nat. Hist. Soc.* XII, p. 570), described it as "a jerked out '*hoot-coorroo!*' with 'r' very distinctly toned". This seems to me to convey the sound as heard at a distance. Legge (*Birds of Ceylon*, p. 148, under *Ninox scutulata*) gives it as '*Whok-chok-korok*', which conveys it even better. I have heard the same note, and endeavoured to ascertain its author, at Horawupotana and near Tellulla.

At Mousakande, after creeping through a hundred yards of leech-infested undergrowth in a narrow belt of jungle from which the cry had nightly been proceeding,—scrutinizing all likely holes, dense masses

of foliage, etc.,—I suddenly put the bird off its roost at a distance of only about 6 yards; but as it flew away I saw merely a reddish-brown bird and was very disappointed to think that the problem remained unsolved, for the Frog-mouth and the small Scops Owl are much of a size; both have rufous and grey forms; and both have a similar, silent style of flight. I may mention that, at that time, my own leanings were towards the Frog-mouth as the most likely author of the strange cry.

The search was continued, rather hopelessly, in the direction taken by the bird and, when just about to give up in disgust, I suddenly saw him perched on a low creeper about 5 yards away. In hopes of eluding observation he had compacted himself and elevated his ear-tufts so as to resemble a snag of rotten wood, and would certainly have been taken for such had he been seated on a tree-stump or large branch; but as soon as he realized that his ruse had failed he resumed his normal attitude, glared malevolently at me with his yellow eyes, and decamped.

He appeared to be in an intermediate colour-phase between the extreme grey variety, represented in Legge's Plate, and the light chestnut form of which the Colombo Museum series alone consists. The row of white spots on the scapulars was particularly noticeable, and, in the snag-mimicking attitude mentioned above, helped considerably to enhance the cryptic effect by destroying the appearance of solidity in accordance with " Thayer's law ".

The roost was in a not very dense bush about 4 feet from the ground and the droppings, etc., below showed that it had been used for some time. The only ' casting ' found consisted of beetle remains.

Legge, on the authority of Bligh, gives this little owl a most bloodthirsty character, attributing to its predatory activities the remains of various small birds and other vertebrates found on Mr. Bligh's verandah; but I have no doubt whatever that the real marauder was one of the Ceylonese Vampire Bats, *Megaderma spasma* or *Lyraderma lyra lyra*, which are well known to bring their vertebrate prey at night into verandahs and similar places, and, hooking themselves to the rafters, devour it, leaving such remains as wings, legs and feathers below to testify to the nature of their prey. It is very doubtful if the little Scops Owl ever aspires to vertebrate prey higher than geckoes and its normal food probably consists of insects such as beetles and grasshoppers.

A perusal of ornithological publications shows that there is still much to be learnt about the notes of owls, and in many cases these seem to vary enormously in the same species in different parts of its range; for instance, the ordinary call of the Collared Scops Owl, *Otus b. bakkamoena*, in Ceylon is a loud " *whoh* " almost like the word ' what ',

uttered in a staccato tone but with an open sound at the end, repeated every few seconds for minutes at a time. Occasionally, in flight, it gives out a loud "*Wā, wā, wā, wā, wā*", in a descending scale. A loud growl when cornered, and a shrill, chittering note, expressive of either pain or pleasure, almost complete its répertoire as far as I have heard it. However, Stuart Baker (*Fauna Brit. Ind.*, *Birds*, 2nd Ed. Vol. IV., p. 424) gives the note as "a soft '*too-whoo*' of two syllables run into one...constantly repeated", and Osmaston (Birds of Pachmarhi, *J. Bombay Nat. Hist. Soc.* XXVIII, p. 458) says that "the note '*kurook-took*' is repeated after dark at regular intervals ad infinitum". This refers doubtless to the sub-species *Otus bakkamoena marathae* Ticehurst, but it suggests the note of *Otus sunia leggei* rather than that of *O. b. bakkamoena* as heard in Ceylon.

G. M. HENRY.

3. Albinism in Ceylon Macaques

Plate XXXIX

Albinism is known to be common among Ceylon animals, occurring frequently among such diverse forms as squirrels, crows and kraits. Among monkeys, however, albinism is very rare. It has been known to occur in a partial form among the various races of the Purple-faced Langur (*Pithecus senex*) for a considerable time: in fact the type specimen of this species appears to have been one of these partial albinos. As far as this species is concerned the condition has been fully dealt with by W. W. A. Phillips in this journal (1926). No case has yet been reported of complete albinism in any Ceylon monkey. By complete albinism, I refer to the condition which includes, besides complete absence of pigment from the hair, absence of pigment from the skin and the iris. This complete degree of albinism is exceedingly rare in all Primates other than Man. Schwarz (1910 and 1927) has recorded the condition in certain species of the African genera *Cercopithecus* and *Cercocebus*, in which partial absence of pigment also frequently gives rise to erythristic and flavistic phases as variants from the normal browns and blacks. But there are no records of complete albinism in any other genus of monkeys. It is with the purpose of recording the occurrence of complete albinism in the genus *Macaca* that the present note has been written.

Up to the present time I have come across three specimens of complete albinism in the Toque Monkey (*Macaca sinica*). Two of these I have seen personally, and occurred in captive animals. The third I quote on the authority of Dr. Lucius Nicholls, who tells me that he saw a pure albino specimen amongst a troop of normal individuals in the jungle between Anuradhapura and Madawachchiya, N.C.P.

Albino *Macaca sinica*. ♂ juv.

Of the two specimens of which I have personal acquaintance, the following notes may be added. Both were originally from the dry-zone forest, one from Kantalai, E. P., and the other from the Trincomalee district. All three specimens are therefore from the dry-zone, and if ever the species has to be split into local races (as Pocock, 1931, has attempted to do) all the specimens would probably have to be regarded as of the same subspecies.

The older of the two captive specimens was a fully mature female over three years old. She was in captivity at Veyangoda, but her original home was given as Kantalai.[1] Her hair was pure white everywhere. She had no pigment in the usual situations in the skin, which was everywhere pale pinkish, save for a few brownish marks on the tail. Her eyes were of the characteristic albino type, the vessels of the iris giving a reddish glare. Like human albinos, she kept her eyes nearly closed, especially in strong light. Her skin seemed to be excessively delicate, as her keeper found it impossible to keep her on a chain for very long on account of the damage done by the belt she wore. She was menstruating quite normally at the time I saw her, and I was told that she did so regularly at monthly intervals.

The other captive specimen resided in Slave Island, Colombo.[2] This was a young male, not yet sexually mature, and therefore probably under three years of age (see Plate XXXIX). He was quite a lively animal, and his condition appeared to affect his life but little. He did not seem to mind the strong light in the least. Like the female described above, he was pure white in hair colour all over, whilst he also lacked pigment in the skin. He was captured as an infant in the Trincomalee district.

In discussing these animals the question naturally arises as to the diagnosis of the species. This, of course, is comparatively simple if the animals are seen in their native land; but one naturally asks: Would it be possible to diagnose them as Ceylon macaques had they been seen alongside albinos of other species, and especially of the nearly related Indian Bonnet Monkey (*M. radiata*)?

From my earlier paper on the Bonnet Monkeys (1932) it is evident that the chief matter of difference between the Indian and Ceylon forms of Macaque is in the pigmentation of certain skin areas of the latter, especially the ears, lips and eyelid margins. In the albino these distinguishing marks are absent. What then decides their specific rank? In the first place both specimens examined have the typical arrangement of the bonnet; in the second place both clearly showed the characteristic whorl of hair in the preauricular region (cf. Pocock, 1931, and also the present writer's paper). These two factors alone are sufficient to indicate the species to which the albinos belonged.

W. C. Osman Hill.

[1] This specimen is now in the Zoological Gardens, Dehiwala [W. C. O. H.]

[2] The mounted skin of this animal has just been received at the Colombo Museum. (Ed.)

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